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Preservation of Heritage in Iraq using AR

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ABSTRACT

Augmented reality (AR) has come a long way in the past few years. From requiring special devices and hardware into the palm of our hands. The advancement of smartphone and tablet hardware enables beautiful, precise and engaging AR experiences. This article explores the application of AR experiences in the context of cultural heritage digitization. AR has a lot to offer the digitization of cultural assets, especially when it comes to situations when it is crucial to preserve a country's culture and historic objects. This is particularly evident in nations with rich historical legacies and old civilizations, such as Iraq. However, violent situations, war, and catastrophic occurrences have continuously threatened to erase this rich past. Future generations may be protected by using AR as a potent tool for not only conserving but also presenting and teaching people about these priceless cultural artifacts. The proposed AR application is developed using SwiftUI's Model View View Model (MVVM) programming model. The experience's AR capabilities utilize ARKit 6 framework and RealityKit framework for AR. These frameworks provide unparallel AR abilities for tracking, positioning and rendering 3D objects. Furthermore, ARKit provides the ability of building collaborative AR sessions across multiple devices for a shared AR experience.

KEYWORDS

Culture Heritage, Iraq , Augmented Reality, ARKit, RealityKit

INTRODUCTION

Preservation of culture's history is one of the most significant tasks of each nation. yet safeguarding the past knowledge and heritage can be a difficult task [1]. Specially in developing countries, where wars and conflict have led to the destruction and looting of a millennia's worth of artifacts [2].
Iraq, a cradle of ancient civilizations such as the Sumerians, Assyrians, and Babylonians, has a cultural heritage that is not only vital to its national identity but also of significant global importance. The preservation of this heritage is paramount, yet traditional methods are often insufficient due to the challenges posed by contemporary socio-political conditions [3]. In response, this paper explores

the implementation of an AR experience aimed at the digitization of cultural heritage within Iraq. By leveraging cutting-edge technologies embedded in widely accessible devices like smartphones and tablets, AR offers a promising solution to preserve, interpret, and disseminate cultural narratives that are endangered.

AR can be described as a digitally enhanced real world. AR combines computer generated objects and the physical world, where 3-dimentional objects are placed inside the physical world environment [4]. The Reality-Virtuality Continuum, defined by P. Milgram and F. Kishino, is described as a continuum with the real world at an end and the virtual world at the other end. Where AR and augmented virtuality are somewhere in-between. As AR is closer to the real world whilst AV is closer to the virtual environment [5]. Additionally, according to [6] there are three key requirements for a system to be an AR system. First, there must be a blend of digital (virtual) and physical (real) content presented. Second, the system must be interactive in real-time. And last, the system must present 3D content.

In the process of preserving the historical and archeological sites, mapping and digitizing the sites is a crucial duty. The primary goals of digital conservation of archeological sites are their discovery, development, and preservation. History will be resurrected by having a digital record of the foundation for the protection of historical and archaeological sites, even in the event that the sites are destroyed [7].

ARKit and ARCore are similar in many aspects. Both frameworks mainly rely on tracking, scene understanding and light estimation techniques. There might be a small advantage in using ARKit over ARCore since the former has been released sooner. Also, the tight integration between iOS and iOS devices enhances the AR experience. Unlike Google inc. which has to support a variety of OEM devices [8]. Moreover, recently released RealityKit adds another dimension to ARKit. RealityKit enhances AR experiences with rich functionality on top of ARKit. RealityKit is another framework that can be used alongside ARKit to develop realistic AR applications [9]. RealityKit provides photo-realistic rendering, camera effects, skeletal and transform animations, rigid body physics, spatial audio and more [10].

This paper presents an innovative idea to utilize smartphone AR capabilities in preserving the ancient and precious artifact in Iraq. AR is reaching its peak, so it is essential to experiment with new ideas to try and harness the power at the palm of our hands in order to find innovative solution to current problems. This paper suggests to utilize the latest technique in object capture, making a workflow that requires no 3D object models to be designed. Furthermore, SwiftUI MVVM is suggested as a programming model to bring lightness and fluidity to the final system.

Literature Review

The excitement around AR is great. There are numerous applications harnessing the power of AR.

Mobile indoor navigation system is an application for navigation inside buildings. This application relies on AR for positioning since GPS signal is weak indoors. This application uses iOS as a platform and specified algorithms for route calculation. After inserting the starting position, the route is overlaid using AR [11].

In his thesis, N. B. Zachariadis discusses the implementation of a disaster management iOS application to help rescue teams and disaster management teams. The application can coordinate between team individuals and preview AR data on the device screen. AR data can be shared and location based so that all team members are updated with the latest information [12].

AR has had great impact on education. An experiment of an electric circuit design has been implemented using AR technology for students majoring in physics. The experiment shows how electricity can flow in a visual manner. Envisioning such phenomenon greatly helps in the learning experience, making it more engaging and simpler to understand [13].

Another application of AR is in the military. Where an HMD is used to detect map data processing issues for soldiers in the battle field. The HMD overlays information over the real world that may include the position of hostiles in and around the area [14].

AR provides a new method for children education in primary schools. It helps teacher explain and show an engaging and live experience of different world scenarios. Such as the solar system AR, this experience is much simpler for children to understand using AR. Primary school students can see and

interact with planets within the solar system. such applications introduce an enjoyable and exciting method of learning [15].
AR introduces new dimensions to the field of medicine as well. Images from various medical sensors, such as MRI, ultrasound or CT scan, can be super imposed for surgeons during operations with AR technology. This can assist surgeons with live overlays and real time Xray vision of the internal anatomy [16].
Moreover, exposure therapy is a form of phobia treatment in medicine. Basically, patients with some phobia conditions are exposed gradually in a supervised manner to their fears to help overcome them. However, it is not acceptable or applicable sometimes to introduce a real fear trigger to a phobia patient. Here AR is the perfect substitute where fear triggers can be introduced digitally to the patient to help in treatment. An example of such an application is presented in a paper by [17], where they treat patients with phobia of lizards and cockroaches using AR.
There are numerous other applications of AR. With the advancement of the hardware and software, many other capabilities are added that can be beneficial in a variety of disciplines and areas [12].

PROPOSED AR-BASED MODEL

This paper discusses the implementation of an AR application in order to aid in the upkeep of ancient and precious artifacts. The notion is that curators, heritage managers or art handles can make a 3D scan of historic objects, which can be saved as a .USDz file. These 3D models can be saved and shared amongst the personnel concerned using all traditional sharing methods, such as sending over the internet or airdropping if in close proximity. This way, a single 3D model can be made available in an instance anywhere in the world instead of having to ship a real physical object. Additionally, these artifacts can be viewed in a shared session with many interested people at any time.
The application considered in this paper relies on a number of technologies that combine to produce a workflow. The application workflow diagram can be seen in figure 1.

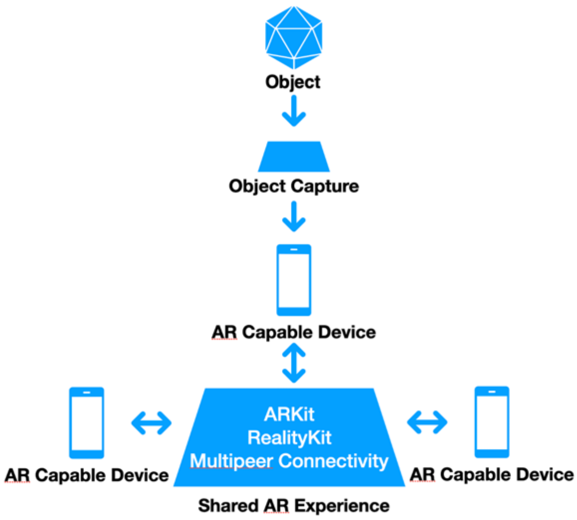

Fig. 1: Application Workflow Diagram.

3.1 Object Capture

Object capture is an API developed by Apple Inc.. the API relies on a process called photogrammetry. Basically, Object capture takes in images of a 3D model and reproduces a high-quality 3D model from the images. Using macOS 12 or later, 20-200 images of an object can be fed into RealityKit using photogrammetry session. The session produces a 3D model which can be used in Reality Composer, iOS device or postproduction software such as Maya3D [18]. see figure 2 for a typical photogrammetry workflow.

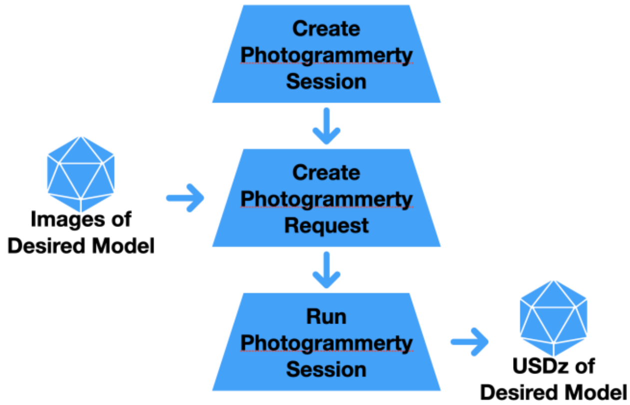

Fig. 2: Object Capture Workflow.

Relying on object capture, RealityKit and photogrammetry session, a simple application is developed. The application is instantiated with a photogrammetry session that would take in the images of the desired object. These images are used to reconstruct an 3D model in the form of a USDz object. Afterward, the generated 3D model can be is used as a digitalized version as required.

3.2 ARKit

ARKit is an AR framework developed for iOS and iPadOS. ARKit 6, the latest update of the framework, comes packed with features and possibilities for AR. Such as, Depth API, People Occlusion, Scene Geometry, horizontal and vertical mapping, etc. Moreover, ARKit utilizes the LiDAR (Light Detection and Ranging) sensor available on news iOS and iPadOS devices to accurately position object in the real environment [19].
The application developed uses ARKit technologies to accurately map the surrounding environment and place 3D models accurately within the AR experience. Objects in ARKit can be place with hit-testing. When a screen tap is registered. ARKit tries to estimate a plane onto which corresponds to the tap location within the AR environment. This is done using the LiDAR sensor to map the area around the device, and converting the tap location into a world transform position.

3.3 RealityKit

as mentioned before, RealityKit is a framework that works alongside ARKit. RealityKit is more concerned with developing realistic rendering, animation, shadows, physics and spatial audio sources within an AR environment [9], [10].
RealityKit techniques are used in this application so that 3D models can be rendered in the AR scene with the highest quality possible. An anchor entity, part of the RealityKit framework, is used to place objects in the scene based on the target component. Then a model entity is used which has the rendering components that produce realistic rendering in the scene.

THE APPLICATION

The application utilizes a host of innovative technologies to achieve its goal. The application provides state of art AR experiences which exploits the power of ARKit tracking, scene understanding and light estimation to create an accurate AR environment. While Realitykit provides realistic rendering, shadows and shaders. AR generated objects can be indistinguishable from real physical objects within the AR environment.
In regards to the sharing options provided by the application, multipeer connectivity is used to provide each device with their own AR shared object instance. The object in question is shared by the main device to all connected peers. This way each other device can have their own unobstructed view of the 3D model. Avoiding overcrowding the area around the Object to be studied.

RESULTS

The proposed AR application provides a new and seamless way to protect historical artifacts using AR technology. This approach enables the safeguarding of significant objects against damage, decay, destruction, or looting. The AR experience is responsive and precise, leveraging ARKit for accurate tracking and scene understanding, while RealityKit ensures realistic rendering. Additionally, sharing data across devices is made easy with multipeer connectivity, which does not require pairing or other forms of initialization. Simply holding the devices adjacent to each other on the same local area network establishes the connection.
Comparatively, another AR project using ARKit, RealityKit, and Multipeer Connectivity, developed in UIKit, showed similar performance in terms of CPU and memory usage. Both applications have an idle CPU usage of around 93%, peaking at 100%. Memory usage is slightly higher for UIKit at 985MB compared to 530MB for SwiftUI, with both having a high energy impact. The similarity in CPU usage is due to the fact that AR technologies in SwiftUI are still hosted in UIKit framework objects, resulting in identical performance regarding AR technology.

CONCLUSION

The application of AR technology in cultural heritage preservation presents a novel and effective approach to protect and share historical artifacts. By utilizing advanced frameworks and technologies, this method offers a highly accurate and realistic AR experience, ensuring that precious cultural heritage is preserved and accessible for future generations.
Smartphone augmented reality (AR) technologies appear to have reached a stage of full maturity. While developers can rely on well-built frameworks to achieve a level of realism previously unimaginable. Tracking is exact and scene understanding is much more detail with the introduction of LiDAR, advanced gyroscopes and high-quality cameras. Using such techniques enhancing the learning experience. Specially in cases were acquiring or sharing objects is difficult.

Given the importance of preserving cultural heritage, this study emphasizes how crucial it is to smoothly incorporate AR technology with SwiftUI. Not only does this improve technological skills, but it also creates new opportunities for accessible and immersive learning environments, especially when it comes to cultural heritage. Our common legacy may be better appreciated and understood by involving audiences in the study and preservation of historical and cultural items through the use of AR.

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