CSE 237D - Maya XR (AR) Final Report

1. Abstract

Maya culture never fails to attract people's attention. Despite its sudden disappearance in 1679 AD[4], archaeologists have always been exploring the ways to reconstruct the Maya ruins. Evolved from ancient days hand-sketch recording to modern days digital scanning, archaeological researchers can now use lidar ,photography, and Augmented Reality(AR) to reconstruct archaeological sites. In this project, we use reconstructed digital Maya archaeological 3D models to build AR applications that enable users to experience Maya excavation sites with their smartphones.

2. Introduction

We know who we are by learning from our past. Ancient records that illustrate our origin may also give us some directions where we go in the future. These valuable ancient artifacts and archaeological sites are gradually being destroyed due to the extreme nature disasters like flood, wind, rain, dust or due to artifacts looting that decrease the preservation value of the entire archaeological sites.

Even though these archaeological sites are well-preserved, few people are willing to look at these records whether by watching online archaeology documentaries or going to an actual museum. Let alone spending huge expense buying flight tickets going to the middle of hot and dry desert to visit a dark abandoned archaeology site under the danger of being bitten by snakes, spiders, mosquitos and the possible robbery in the trip.

The advance of modern digital technology provides solutions for above issues. We can use lidar and photography to preserve the archaeological sites and (Augmented Reality)AR to provide people a virtual experience. AR technology is more accessible than VR(Virtual Reality) technology since most people have a smartphone, but few of them have a VR headset. Besides, Apple, Inc announced their plan to develop AR glasses that can connect with iPhone, this can provide comparable experience with VR headsets when we use the Maya AR application on our smartphones with smart glasses.

Related Works

Augmented Reality has been used in archaeology, mainly to provide a form of augmented tourism, an extension of the classic audio tours.[1] One example is from George Papagiannakis's team[2], they created a well-known AR application for Pompeii. By using the video-see-through HWD(Head-Worn Display) with real and virtual world dynamical modelling, they can insert virtual characters in different buildings and entact a storytelling scenarios.

Some researchers also use AR to help them understand excavation sites. They can reinsert the full-sized roundhouses into the landscape and see how the crowding of them would have affected the overall views across the landscape[3]. This helps them to understand the relationship between each relic even though there is a lack of physical objects.

Contributions

After conducting research on the app store of similar AR portal apps, Maya AR app has following advantages:

- Accessible experience
  - With no needs to go to the real excavation sites, we can use the app to gain virtual experience
  - Travel to different locations and gain different information with only a clicking of the button
- Accurate and professional
  - Most similar apps in the app store use the model that is created by artists or download from Unity asset store, our model comes from the real excavation site.
  - The audios introduce the excavation sites come from the maya archaeology researchers
- Immersive experience
  - Most AR portal apps have to hold phones horizontally to experience the model, our app can use joystick and touchfied to move to any position.
  - Users can have interaction with the object in the sites that introduce the history of the relics with touch of the screen.
  - It can use the game mode to have real interaction with the maya archaeology sites with collision detection

We aim to use Augmented Reality(AR) to create applications that can achieve these goals, with no needs to purchase equipment like a VR headset. AR tech can be experienced with the smartphone that supports ARKit(iOS) or ARCore(Android). In AR, the model is blended with reality, this can be really helpful for applications like virtual monitors that need the interaction both in reality and virtual reality. But in terms of immersive experience, holding a smartphone installed with an AR app is no comparison with the VR headset that covers all your views.

After entering the AR portal, users can experience the excavation sites in real scale. They can either hold their phones to slowly explore the sites or use the joystick and touchfield to go wherever they want to inside the archaeological sites. They can also switch to the game mode to have a real interaction with the maya archaeology site.

3. Technical Material

Software

The main software for this project was Unity Engine version 2019.2.20f1. Unity provides a cross-platform solution for different types of devices. We can develop our application in Unity then export them to a targeted platform. In this case, we are building an iOS application, so we exported the Unity to iOS platform and use Xcode 11.4 to build the exported iOS project into a physical iPhone device. The core plugin we use is the Unity AR foundation, it allows us to display the model we build in Unity with AR presentation in our device. It also provides a set of scripts that facilitate AR application development such as the planeDetection scripts, AR session manager, AR Camera etc. We also experiment with other Unity AR plugins such as Vuforia when we are developing the play audio function, but we give up using it as the main AR development framework due its inflexibility for refactoring.

All the actions inside the application is controlled by the scripts written by C#. Unity provides an intuitive script control UI by simply dragging the scripts to the targeted game object. We use the shader tech to achieve the portal effect. Shaders can be understood as game object material property, we add an transparent game object at the entrance of the portal, when this entrance game object detects the collision from the camera(this means someone is entering the portal), it changes the shader property of the gameobject inside the portal as visible. When we get out of the portal, the portal entrance game object again sets all the maya archaeological sites model shader property as invisible. That is why we can only see a portal with no display of other maya archaeology models after we get out of the portal.

Software such as Sketch and Keynote were used to create UI assets, combined with Unity canvas editor, we are able to design UI/UX experience for users.

Hardware

The application was developed on a MacBook Pro running OX 10.15.2 with 16G RAM. This ensured we would have rapid deployment times and adequate hardware to learn and try new things using Unity Engine. Also we use an iPad to create all the UI elements for the application.

The AR hardware used was an iPhone XR running iOS 13.3.1, with 128G storage that enables developers to experience different app prototypes.

Assets

The project uses 2 Maya archaeological locations M-71 and Diablo which are

located in Guatemala. The model contains Mesh material and .FBX prefab. The audio resource has an English and Spanish version, which is recorded by archaeological researcher Tom Garrison. It introduces relics' cultural meaning and history inside these two archaeological sites.

C# Scripts

These C# scripts were used to achieve all kinds of gameobject functions in the applications.

- CameraController
  - Handle Camera Movement and view change
- Dropdown Menu
  - Control the menu drop down buttons which can be used to switch scenes
- JoyStickMovement
  - Script to use JoyStick to control the camera and character movement
- MainMenu
  - Control different buttons state on the main menu
- MovementController
  - Script to control the camera movement to different locations
- Options Menu
  - Load different scenes when touch different scene options
- PlaceAudioCanvasController
  - Script that control the canvas to play the audio
- PlaneController
  - Enable and disable the plane detection
- PortalControl
  - Set the maya model as visible when camera enter the portal
- PortalPlacer
  - Control touch input to place the portal
- SceneLoader
  - Script to load Loading Scene page
- SoundController
  - Script to play the audio when the play button is pressed
- LeanMotion
  - Script to scale, move and rotate the gameobjects

4. Milestones

Week 3: April 13 - April 19
- Introduced to the project, got started working on the AR game to become familiar with Unity and workflow to develop iOS app.
  - Build an AR spinner game that supports multi players to play in a battle arena. Become familiar with the Unity AR foundation and iOS AR app development workflow.

Week 4: April 20 - April 26
- Learn Unity Shader techniques to create AR portal effect
  - Build a simple version of AR portal without plane detection technique
  - Load part of M-71 Maya model inside the portal
  - Use the point cloud for plane detection

Week 5: April 27 - May 3
- Explored the Vuforia plugin and build play audio functions
  - Give up using Vuforia and Switch to use Unity AR foundation
- Implement AR Canvas to choose different languages to play audios

Week 6: May 4 - May 10
- Implemented UI to enable and disable plane detections
  - Allows users to disable plane detection after entering the portal
- Implemented Menu System
  - Main menu contains Play, Option, Quit buttons
  - Option menu contains dropdown submenu to switch to different scenes
- UI buttons in AR mode to switch to change views of the scene and back to main menu
  - Allows the user to change the location of its position
  - Allows users back to main menu to change to different scenes

Week 7: May 11 - May 17
- Finished MVP and work on extended functions
- Add joystick to control the camera movement
  - Users can use joystick to control its movement if the space is limited
- Add touch field to enable move vertically and rotate horizontally
  - User can use touchfield at right bottom corner to move up and down, rotate left and right

- Add lean motion script to scale, move, rotate the game object

Week 8: May 18 - May 24
- Worked on game mode
  - Implemented joystick to control the character movement in the scene
  - UI button to jump
  - Touchfield to control the view
  - Footstep sound and jump sound.
- Enroll Apple Developer Program
  - Prepare development license for submitting the app

Week 9: May 25 - May 31
- Polish UI/UX design
  - Created UI elements using Keynote and Sketch
  - Simplify the UX design, user can follow the pop up canvas to experience the app
- Add Help page
  - User can learn how to use the app by switching to different funny guidance page drawn with iPad
- Add about page
  - Brief introduction to this app
- Exported Unity code into Xcode platform and submit to the app store
  - 8 hours later, app launched to the app store with name "Maya AR"

Week 10: June 1 - June 7
- Marketing the app
  - Post app demo videos to the social media
- Get user feedback
  - Use google form to get user feedback, and make edition for the next app version
- Documentation
  - Added documentation and code method introduction on website

5.Self-Reflection

I.   I started this project with no experience with Unity and Xcode, this means that I need to learn everything from scratch. I bought a 10 bucks course on Udemy to learn how to use Unity to build an AR game, this helps me to understand the workflow for the development.

II.   The movement for the camera can be really challenging, since you need to ensure the precise position presented in your phone like presented in your Unity development environment. Sometimes the portal is too far, sometimes it is too close. I figured out the ARsession Origin is the position where the user is. So I set every other origin to 0 and set the suitable scale and location to present the model on the phone.

III.   Not having the big picture of how the final project will look like. Most features have been added in the last two weeks without user investigation etc. Some features may look cool but do not necessarily provide good experience. For instance, with a touch field and joystick, you can move to any position you want inside the model (At first we only want to explore the model horizontally), but the touch field is too sensitive and requires great skills of control. Next time, I will list all the features into the plan before the actual implementation.

IV.   After we launch the app to the app store, really few people try to download it or rate it after 2 weeks of app launch. Possible marketing strategy is to make an app usage videos and post it to social media platforms like Youtube, Twitter. We can also start an Apple app ad to promote the app in the app store.

V.   The Maya XR project was thought to be one project, since I and my teammate work on different aspects, it finally split into 2 seperate projects. I think there will be some collaborations, but it turns out we are completely independent. I hope if we have more clarifications at the beginning of the quarter on each member's responsibility, I can avoid making mistakes that may lead to plagiarization or creating an impression that I am a free rider.

6.Conclusion

In this project, we build an iOS AR application with Unity and Xcode and launch it to the app store. This application allows users to experience Maya archaeology sites using iPhone/iPad with iOS 12.0+. The targeted users include archaeological researchers and maya culture enthusiasts. This app proves the feasibility to use modern digital tech to preserve ancient archaeological sites and use AR tech to let people experience these excavation sites with their smartphones. The user experience is not perfect due to the limited development cycle and users feedback have been collected for the next version development.

For the next version of the app, more interactions will be added. For instance, we can place some ancient maya artifacts inside the AR mode, users can tap these artifacts game objects and it will pop up the introduction canvas. We can also add social functionality, so that users can invite their friends to visit the sites together with an avatar display. For game mode, we can turn it into horor Maya temple game, where lots of spiders and snakes will try to attack you, and it can be killed using weapons like pistols or knives, you can also invite your friends to join the game to start Maya adventure.

Link for the app: https://apps.apple.com/us/app/maya-ar/id1515428322

7.References

1. Augmented Reality, a New Horizon in Archaeology By: Stuart Eve, University College London and L – P : Archaeology
2. Papagiannakis, George, et al. "Mixing Virtual and Real scenes in the site of ancient Pompeii." *Computer Animation and Virtual Worlds* 16.1 (2005): 11-24.
3. Bender, B., Hamilton, S. & Tilley, C., 2007. *Stone Worlds: Narrative and Reflexivity in Landscape Archaeology (Publications of the Institute of Archaeology, University College London)* illustrated edition., Left Coast Press Inc.
4. Demarest, Arthur (2004). *Ancient Maya: The Rise and Fall of a Forest Civilization*. Cambridge, UK: Cambridge University Press. ISBN 978-0-521-53390-4. OCLC 51438896.