

Augmented Reality Game Development using Unity3D

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Abstract- Mobile augmented reality (mobile AR) enables virtual content such as 3D models, animations and annotations to be placed on top of a real world objects in any context. We applied mobile AR to develop our own AR action game to expand the AR genre of games in Android. In this game, the player controls a warrior to fight another warrior in a tournament to become the champion. We present the development of the AR game using Unity 3D and Vuforia. Unity 3D provides a simplified way of developing any game by providing all the basic tools and physics system for the game environment. Vuforia plugin of Unity 3D provides the necessary API for detecting planes and object placement in AR environment. A mixed-method usability evaluation on children and university students indicated that especially interaction with AR content and user interface clarity were improved in the Unity 3D version. We expect game engines such as Unity 3D will become essential for developing AR applications in future.

Keywords—*combat; mobile game; game engine; augmented reality*

I. INTRODUCTION

Today, ubiquitous technologies develop rapidly and are widely spread. As a consequence, many citizens in developed countries use the smartphones in which making phone calls has become a secondary function. Smartphone platforms, such as iOS and Android, provide not only highly sophisticated computing and context sensing infrastructure but also open markets which contain a variety of applications and services for users to benefit from. With the prevalence of smartphones, the interaction between humans and the context through ubiquitous technology has been given more attention. One of the means to enrich this interaction is augmented reality (AR) in which virtual content is placed on top of a real world camera view. AR can provide additional contextual information and enable more realistic interaction experience with virtual content. At the moment of writing this paper, there are hundreds, if not thousands, AR applications available for smartphones. Many researches have been conducted on augmented reality in the fields such as tourism[1], shopping[2], education[3] and entertainment[4]. Early AR applications required the user to carry a computer and a Head Mounted Display (HMD) but in this study we focus on mobile augmented reality (mobile AR) which is enabled by handheld devices such as smartphones. Mobile AR enables unobtrusive gathering, managing and utilizing contextual information and providing AR-enhanced services based on the user's context.

One of the great challenges in the development of AR games is that there are not many resources in for developing such games. AR is a developing field with advances every day. Since there are no AR combat games, this will help to provide future references to build more such games.

In this paper we explain our experiences and challenges developing the combat AR game. We also explain the technologies required to build the game. The game is created in Unity 3D which is a game engine used to develop 2D as well as 3D games for various platforms. Using the Vuforia plugin in Unity3D AR games can be developed for mobile devices. Vuforia uses the camera and gyroscope of mobile devices to detect planes and place/spawn objects. We also analyze various AR games developed and the Augmented Reality systems used to develop them.

II. BACKGROUND

A. Augmented Reality Systems

In early augmented reality systems the users carried a computer and/or some form of Head-Mounted Display (HMD). MARS, Studierstube, AR Quake, AR Pacman are examples of such early AR systems. MARS (Mobile Augmented Reality Systems) consist of a computer with 3D graphics acceleration, GPS, See-through HMD, wireless LAN and other components. Studierstube is wearable augmented reality system that makes user to interact with the augmented object by a pen and pad. User equips laptop on his back, a helmet with video output device and webcam and use pen and pad which are track optically by markers and camera. AR Quake and AR Pacman are examples of games that use augmented reality technology. Specifically these are adaptations of augmented reality to popular Quake FPS and Pacman arcade games, respectively. Both game use wearable computers for data processing and require See-through HMDs to show information to the user. AR Phone, MobiAR and GeoBoids are examples of mobile AR that are based on handheld devices instead of wearable computers and HMDs. As a

consequence, the user does not have to carry special hardware which improves mobility. AR Phone is study where a mobile phone with limited processing capabilities is used to provide an augmented reality interface in smart environments. In the AR Phone system highprocessing tasks such as image processing are performed on the AR server and the phone merely performs the role of viewer. MobiAR is Android application that provides tourist information with augmented reality. When users observe the real world through the MobiAR, the view is augmented with information of their location. With multimedia content, users can access useful information to plan their routes in the city. GeoBoids is an exergame that uses AR on smartphones. The game provides Field and Arcade modes where the player has to search and capture virtual GeoBoids creatures in an outdoor real world environment. Interaction between the player and augmented reality objects is simple which is just touch or swipe on the smartphone screen.

B. Challenges in AR Development and Use

Past augmented reality systems suffered from limitations of mobile technology and IT infrastructure. These limitations cause the developers and users to experience several challenges as described below. Firstly, using special AR hardware such as HMD has some problems. HMD disrupt the view of vision and may cause inconvenience to the user. In addition, if HMD has low resolution, it causes difficulties to recognize augmented object and distortion of the sight that differ from real world. Moreover, special hardware is less accessible than common device such as smartphone. The latest example of special hardware for AR is Google Glass, which is wearable computer with an optical head mounted display. Although its technology is sophisticated and design unobtrusive, Google Glass is currently too expensive to normal users. Another problem of Google Glass is that the current version cannot be used by people who wear ordinary glasses. Secondly, implementing augmented reality and building mobile computing interfaces require much time and effort from the developers. In the past, memory and data processing capabilities of mobile devices were significantly lower than today. As shown in AR Phone system, high data processing tasks can be delegated to an external server which performs necessary computations. This issue requires developers to build an infrastructure for external data processing and communications which, in turn, inflict latency to user experience.

Because of these limitations smartphones containing a camera, high performance processing unit, high resolution display and context sensing capabilities have emerged as potential platforms for implementing mobile augmented reality. Yet, implementation of AR can still be a complex task. Today there are many AR libraries, such as Qualcomm's Vuforia, to alleviate this problem but they often lack direct support for processing of and interacting with virtual objects for the purpose of gaming. This, in turn, can increase time required for the development of mobile AR games.

III. DEVELOPMENT

A. Design

The AR game is developed on Unity3D and Vuforia plugin. The game is a 2-player combat AR game. The user points the camera to the target image and the player spawns on the target image. The opponent does not require a target image to spawn. The target image acts as a plane for the game objects.

The game has a basic UI. For example, a simple main menu with Play, About and Exit options. The main game scene has players, with each player having a health bar. The user controls the character with a floating joystick. There are buttons for attack and special moves.

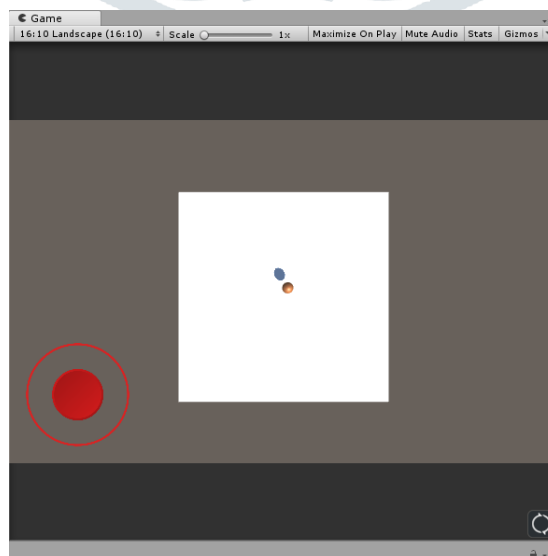


Fig. 3.1: Joystick for Character Movement.

The game has the following storyline:

The game is based on an ancient tournament. A tournament between clans. Each clan sends a representative for their clan. These representatives have distinguished themselves as the strongest warriors among the members clan. Now they represent their clan in this tournament. The clan that wins the tournament gets to rule over the world for a year. Each clan is in a haste to victory. The tournament is a simple tournament where the warrior has to fight each of the clan once and obtain the most amount of points. The winner gets to challenge the almighty God. If the warrior defeats him, they rule the world.

The character models are designed on Blender3D and animated using Cinema4D. All the basic UI components are default Unity3D UI objects. Other components like Health bar and action buttons are designed on Photoshop.

B. Implementation

The game is implemented on Unity3D. A scene is created for the game. The default camera is replaced by AR camera provided by Vuforia plugin. The plugin comes with pre-written scripts. Unity uses C# scripts for all the game functions, example, for player movement using joystick, special moves implementation, etc. Whole game and scenes are controlled using C# scripts. An example Character implemented is:



Fig. 3.2: Mutant Character

Some of the humans underwent mutation and now they form the mutant clan. They are brutal, ugly and decide everything on a fight. Killing is their way of survival. A competition to select the representative exposed Rex the Tyrant, the mutant with the most bloodlust. He is ready to tear apart his foes in the tournament. Base Stat- More HP. It has the following special moves:

1. Slam- Rex picks up and throws the opponent.
2. Blade Punch- Rex uses his blade to cut open the opponent.
3. Spine Breaker- Rex grabs his opponent and finishes him by breaking his spine.

The hits of opponent and players are detected using Colliders. These Colliders detect any collision on specific parts of the character. These collisions decide the power of the hit.

The apk file of the game is generated using Build settings in Unity3D.

IV. USER EVALUATION

This Game was created to introduce a combat-based game in mobile AR. Hence the target audience were smartphone users and casual gamers. The game was tested on a group of 5 participants ranging from 18 to 21 years old. All participants were given 15 minutes to test the game. The participants were then asked to give a score on the following aspects: learning curve, gameplay experience, user interface, addictiveness and overall experience. The below Table shows the average scores for different aspects as evaluated by the participants. The score ranges from 1 to 5, where 1 is poor and 5 is excellent.

Table 4.1: Game Evaluation

| Sr. No. | Aspect | Average Score (/5) |
|---------|-------------------------|--------------------|
| 1 | Learning Curve | 4.5 |
| 2 | Gameplay Experience | 3.5 |
| 3 | User Interface | 3 |
| 4 | Addictiveness | 4 |
| 5 | Overall Game Experience | 3.5 |

In summary, all participants had a fairly good experience, as noted from the overall game experience score of 3.7 out of 5. There was also some interesting feedback (positive and negative) from the participants:

- Positive Feedback:
 - "Interesting game concept"
 - "Intuitive and interactive gameplay"
 - "Great storyline"
- Negative Feedback:
 - "Only 4 types of characters are playable"
 - "Repetitive gameplay, should include more gameplay variations"

V. CONCLUSION

Smartphone-based mobile AR solves challenges that past AR systems had, including inconvenience of head-mounted displays and computer backpacks as well as requirement of external data processing infrastructure. In this paper, we present the development of an AR action game developed using Unity 3D and Vuforia as an AR plugin which uses the mobile device camera to find target images which spawn the player characters. In the game, user can select from a range of four characters and fight against a computer-controlled opponent. The implementation of AR in combat improves the gameplay experience as the user gets the feel of playing the game in the current environment. In future, we intend to add features like terrain changes, location based multiplayer battles and more set of characters to choose from. This will allow social interaction between players and the feel of playing the game in the surrounding environment.

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