

Meowgical AR – A Game based on Augmented Reality

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ABSTRACT

This paper presents the process of developing the Meowgical AR application, a multiplayer game on the phone that uses Augmented Reality technology to provide the user with a special experience. One of the main objectives was to make a game that looks nice and simple at first glance, but behind which are several levels of complexity and strategy. This goal has been achieved by adding several unique abilities that can be combined anyway to each game, equipment that interacts with the abilities and effects that help or confuse the player for a short time. Another important goal was the possibility for the user to customize elements of the game in order to have a unique experience. Through the possibility of customizing the character and building your own arenas, this goal has been achieved.

Author Keywords

Augmented Reality; Game; 3D Modelling.

ACM Classification Keywords

H.5.2. Information interfaces and presentation (e.g., HCI): User Interfaces. H.3.2. Information Storage and Retrieval: Information Storage.

General Terms

Human Factors; Design.

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INTRODUCTION

Augmented Reality (AR) creates new immersive experiences for entertainment, games, and educational applications [1-5]. In recent decades AR technology has evolved and grown in popularity, it being present in more and more applications, which can be seen in the popularity of filters on social media applications (Instagram, Facebook, Snapchat), the emergence of many games that combine the fantastic with the real like Pokemon GO and in the creation of devices that can be used in everyday life, such as Project Aria¹. Games are an interesting environment for the application of AR technologies. Combining virtual elements with real objects leads to an immersive experience, beneficial for the user experience. Phones have also become powerful enough in recent decades to allow the use of AR applications, which is an advantage in terms of game accessibility. Special

augmented reality headphones are still expensive enough, but a phone is owned by almost anyone. We chose to make a game with the characteristics of a MOBA (Multiplayer Online Battle Arena) [6], but which uses AR for a unique experience. The characters of the players are magical cats, a decision made because cats are among the most popular pets in the world. We also wanted users to be able to customize as many elements of the game as possible, so that their experience is as pleasant and personal as possible.

SIMILAR SOLUTIONS

Pokémon GO

Pokémon GO² is an AR application that involves collecting fantastic animals from the Pokémon universe. This game was very popular at the time of launch (July 6, 2016) with over \$750 million downloads in the first year [7]. The game encourages movement and exploration, as Pokémon creatures appear in various physical spaces and it takes a close approach to them to discover and capture them. The game also encourages socialization, with users having the opportunity to exchange Pokémon between.

Angry Birds AR: Isle of Pigs

Angry Birds AR: Isle of Pigs³ is an AR application that involves destroying enemies by tearing down structures on them, using all sorts of projectiles. The look of the game is reminiscent of cartoons, and observing these objects in real space gives a special feeling to the game.

PROPOSED SOLUTION

Meowgical AR is an AR application that allows the battle between two players. The aim of the game is to get as many points as possible during a 6-minute match, points that can be obtained by reducing the opponent's life to 0 or by collecting bonuses. Players have access to 5 spells, from which they can choose two in each match. Players' characters can also be customized to differentiate themselves from the opponent. The arena where the battle takes place can be customized, using hexagonal pieces and placing them in any shape. All libraries used are free licensed, and 3D models and effects are made by us or under a free license. The application was built in Unity⁴, using AR Foundation⁵. For the multiplayer part Photon PUN⁶ was used.

¹ <https://about.facebook.com/realitylabs/projectaria/>

² <https://www.pokemon.com/us/>

³ <https://play.google.com/store/apps/details?id=com.rovio.a.bar>

⁴ <https://unity.com/>

⁵ <https://unity.com/unity/features/arfoundation>

⁶ <https://www.photonengine.com/pun>

The 3D modeling part was done in Magical Voxel⁷ (Fig.1).

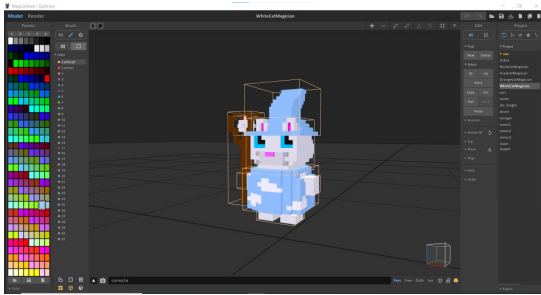


Figure 1. Example of a character made in Magical Voxel

Storing the Arena

Because the arena it's made out of hexagonal pieces and the construction of it begins with the **Start piece**, the usual way of storing a board (a.i. using a matrix) can't be used. The positions of the hexagonal pieces are encoded using a special kind of coordinates [8]. We will refer to this type of coordinates as **Q;R** coordinates. The default arena and custom arenas made by users are stored in a **JSON** format that describes it. During a game, there needs to be a way of transforming from **Q;R** coordinates to 3D coordinates, in order to know where to place each tile in relation to the center chosen by that player. The formula for this conversion it's the following:

$$(q, r) \Rightarrow \left(r \cdot \frac{l\sqrt{3}}{2} + q \cdot l\sqrt{3}, 0, -q \cdot \frac{3l}{2} \right), \forall q, r \in \mathbb{R}$$

Recognizing pieces

For the process of making custom boards, first of all we have to recognize the pieces. **AR Foundation** offers an easy way of recognizing a tracking images, that being the **AR Tracked Image Manager**. This component needs a **Reference Image Library** that specifies the images we want to track and their real-world size (see Fig. 2).



Figure 2. Example of a tracked piece

In a custom script, the list of tracked images is monitored, the corresponding in-game pieces are spawned and their positions and rotations updated.

⁷ <https://ephtracy.github.io/>

Making the custom arena

Users have two ways of building the arena.

- (1) The first one is *Build mode* (see Figure 3). Users build the arena one piece at the time, using the images of hexagonal pieces as colors from an artist's palette. Places where pieces can be placed have transparent placeholders. This mode is also suitable for users that don't have access to a printer – the images can be scanned from a friend's phone or even the PC's monitor.

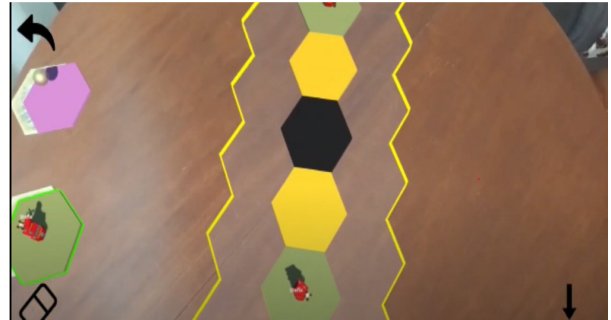


Figure 3. Example of building the arena

- (2) The other available customize mode is *Scan mode* (see Figure 4). Users can print multiple copies of the hexagonal pieces and put them in the way they want the arena to look.

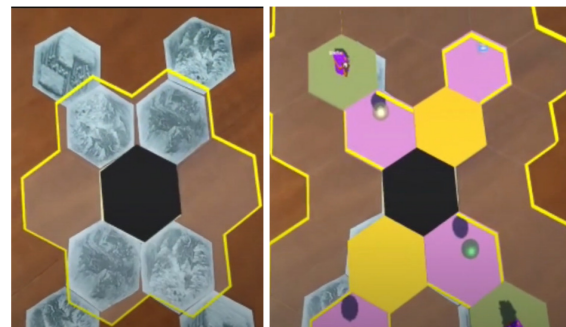


Figure 4. Before scanning (left) and after scanning (right)

Customizing characters

Customizing characters in games is a very important element, because it adds diversity in games (if all the characters look the same, it can become slightly repetitive) and the possibility for the user to express his personality and/or physical aspects in the character he uses. Thus, we made several models for the colors of the characters and the clothes they wear (see Figure 5). In order for the user to control the character, we used Input Actions. Input Actions were performed by Unity to separate the logic of the actions in the game from the input device used. This is the window for Player Actions, an instance of Input Actions, used to control the player. The actual movement of the player is performed

by the Character Controller component. To use the spells, we built an Action Map called “Skills”. The PlayerSpellCasting component “listens” if these actions have been performed and calls the spell usage functions, as appropriate.

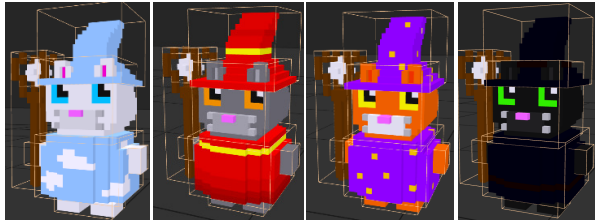


Figure 5. Clothing patterns and character colors

Value for Life and the formula for changing it

For the amount of life and all the attributes that influence its reduction through spells we have written a special class called HealthBehavior, attached to the prefabricated character. To provide an extra level of complexity and strategy to the game, we’ve added an attribute to HealthBehavior called **protections**. **Protections** can be modified by *Equipment* and *Effects*. Another important attribute is **resistance**. It has the value between 0 and 1. The formula depending of these attributes is:

$$currentLife = currentLife - damage.amount \times \frac{100}{100 + protections} \times (1 - resistance)$$

Spells are in a hierarchical class structure. It contains attributes that are common to all abilities: the *type* of spell, the *corresponding image* to be displayed in the UI, the *time* it can be reused.

Spells Indicator - Spells have a different behavior, some spells launch projectiles that stop either after a distance traveled (which may differ from spell to spell) or to collide with an enemy (see Figure 6).



Figure 6. Example of spell indicator during a game

Others can create a circle around the character with various effects (negative for enemies and / or beneficial for allies). The player needs a method to assist him in visualizing these features that cannot be easily memorized, especially in Augmented Reality, where the distance and / or angle to the arena where the battle takes place can differ significantly from game to game, even during the same game. With this in

mind, we developed a system of dynamic spell indicators. The actual display of the indicators is done by the Projector component which applies a material on the surfaces that intersect with its field of view.

Placing the playing arena

Before players can start the game, they must place the arena in augmented reality. They have at their disposal an outline of the arena (generated according to its shape) which they can use to guide themselves (see Figure 7).

It can be rotated, enlarged or reduced according to the user’s wishes. The MakeContentAppearAt function changes the position and rotation of the AR camera inside the scene so that the arena appears to be in place of the contour. It is important to change the position of the room and not the arena, because if each player had a different position of the arena, synchronizing objects would be much more difficult.

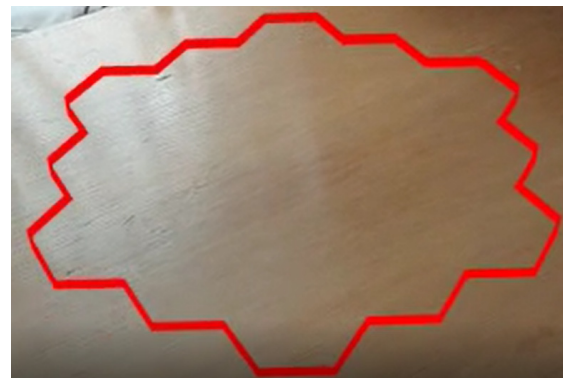


Figure 7. Example of arena contour on a table

USABILITY TESTING

We asked 7 people (5 men and 2 women) that received a demo of the application or watched a video to express their opinions about the game. They are between 15 and 22 years old with experience in using games on mobile phones and in using either virtual reality or augmented reality applications.

For the first question: “What do you think about using Augmented Reality? Does it help to improve the gaming experience?” The answers were:

Nb.	Answer
1	Augmented Reality substantially improves the experience in a game, helps the user to feel more accentuated any action and create the feeling of immersion.
2	Yes, it makes the games much more interesting!
3	I consider the use of Virtual Reality an element that makes the gaming experience more fun
4	My opinion on the use of Augmented Reality is that it’s a good choice; it really helps to experience the game, making the game seem closer to the user.
5	It helps a lot.

6	Yes, it helps.
7	It's an ingenious idea that adds a lot to the player's experience. It complements the game in a natural way."

The general opinion is that the use of AR technology helps a lot and offers a special gaming experience.

For the second question: "What do you think about the look of the game?", the answers were:

Nb.	Answer
1	I think some elements would have looked better if they looked rounded, to the detriment of the straight edges at the moment, but overall the game looks good, looks finished and the animations improve the experience.
2	It looks great, and I really like the characters, it's like they're from cartoons.
3	The look of the game is nice and enjoyable.
4	The look of the game is very nice, everything is arranged in a proper way, the font used matches the theme of the game.
5	It looks nice, cartoony.
6	Simple and friendly
7	The game looks very professional and can be compared to existing products in the mobile gaming market.

For the third question: "What grade would you give to the look?" Grades between 6 and 10 were given, with an average of 8.85. Conclusion: The character design is pleasing to users and reminiscent of cartoons.

To the fourth question: "What did you like most about the game?" the following answers were given:

Nb.	Answer
1	I like the most the ability to combine certain objects with abilities to diversify the style of play
2	The way the characters look + the animations of blows to opponents.
3	The option to customize the cat.
4	The fact that you can customize you character, the spells and items you use and even the arena you play on.
5	The fact that you have access to multiple spells.
6	The gameplay.
7	I liked the integration of augmented reality in the game the most, which brought a big plus combat.

Conclusion: the multiple possibilities to play the game with a large number of combinations between skills and equipment is appreciated by players. Also, the ability to

customize characters and arenas helps a lot in the user experience.

Fifth question: "What grade would you give to the game as a whole?" received grades between 7 and 10 with an average of 9.28.

CONCLUSION

The current application is a stable and extensible base. By adding new skills and equipment, more types of pieces for building arenas, more game modes (in multi-player teams) and improving the interface, the application can become a very complex game, which encourages creativity and socialization. Regarding the future work and taking into account the answers to the last question of the questionnaire, we reached the following conclusions: (1) the possibility of customization is much appreciated by users. To give them the best possible experience, more spells and equipment should be added for an even greater number of possible combinations, as well as more character patterns. (2) The game could also be played in teams, which would increase the complexity of the game, its strategy and popularity. (3) Although the interface received generally positive reviews, it could be modified and improved with the help of animations and colors.

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