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# Capture The Flag: Engaging In A Multi-Device Augmented Reality Game

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*ITS '15*, November 15-18, 2015, Funchal, Portugal  
ACM 978-1-4503-3899-8/15/11.  
<http://dx.doi.org/10.1145/2817721.2823493>

**Abstract**

We present a Capture the Flag based game that investigates the possible engagements in a multi-device game. The distinction between a publicly used space and a player's private space is made and utilized to display different information to players. The tablet and the Augmented Reality component are used to see how players can be drawn to a certain physical space, to create a social and engaging game.

**Author Keywords**

Augmented Reality; Multi-device; tablet;

**ACM Classification Keywords**

H.5.2. User Interfaces: Input devices and strategies, Interaction styles

**Introduction**

There are many different devices used in all aspects of everyday life. Many games typically are played using one main device (e.g. a smartphone, computer, television). Multiplayer computer games are often created so that users can play remotely and do not rely on the physical presence of the other players. However, games are also often played in a social setting. Families and friends often play board or card games together to pass the time.

This project challenges the traditional setup of a multi-player game and examines the possibility of engaging a



**Figure 1.** The game was developed to be played on a large multi-touch tablet and multiple smartphones.

group of players in a single game, while still allowing the possibilities that a computer or video game provides. It uses Augmented Reality (AR), an indirect view of the physical world, to provide each player with his or her own information unavailable to other players. Augmented Reality involves “augmenting the real world with computerized information” [2]. In this case, the real world is locked on top of a shared tablet screen that displays certain aspects of the game to users. This project experiments with different information being displayed on different devices to highlight important information.

### **Related Work**

Previous work has been done to investigate the shared and private spaces to allow the multiple users to interact at once with media facades [5]. This project found that one could avoid cluttering up the space on a shared interface, by augmenting a live feed of the video on a smartphone to give the users more information. Interactions using a live video have not always allowed a natural interaction for the user. Object-oriented interactions use tracking to allow the smartphone to be physically oriented in the real world [3]. This gives the user a more natural of sense of how their interactions will affect the video. This is incorporated through the movement interactions of the user.

Through the implementation of a Tower Defense game, the use of a smartphone as more than a controller was investigated [4]. The game involved using a tablet to provide certain input and using motions and touches on the smartphone as a different source of input. This project focused on a game that did not require time sensitive input from the user, allowing the acceleration and position of the smartphone to be used. In the

capture the flag game, certain interactions that require more precision, such as moving artificially into a tower, were avoided due to the real time nature of the game.

### **Game Implementation**

In order to investigate the possibilities to engage the user with multiple devices, a Capture the Flag game was implemented. The game was created to be run using a XPS 18 Windows Multi-touch Tablet and 2-4 Android smartphones.

The game was created using Unity and written in C#. The UNET networking system from Unity is used to accommodate the multi-device aspect of the game. In order to include features specific to the Android platform, Java plugins were also incorporated. To incorporate the augmented reality features used in the game play, Vuforia was chosen as a free option that could be easily incorporated into a Unity game.

### **Game Play**

The implemented 2-4 player game is based off of Capture the Flag [1]. There is a public space, the tablet, that hosts the game. On this public space, each player’s location and their immediate surroundings are displayed, as well as each of the bases and flags. In addition to the information the players can see on the public tablet, each player receives additional information on the Android smartphone they use to connect to the game. The player’s view of the playing field is enhanced using Augmented Reality, to show the objects and obstacles, or lack thereof, at the locations the player has already visited. This private information is only available to a single player at each location, providing that player with additional expertise of the terrain at that location.



**Figure 2.** Players playing capture the flag on a tablet. The player in the front right is tapping on the table to steal the flag. The players on the left are moving by touching on their smartphones and are blowing into the microphones.

The game begins with each player at their own base. The players can gain the view of the playing field on their devices by pointing the smartphone's camera at the tablet. The Vuforia system can recognize the target, and the objects will appear as a 3D representation over the board. Each player can then move by touching the target location on the game world representation on his or her smartphone. The player can also blow into the microphone on his or her smartphone in order to move faster.

In order to steal a flag from another player, the player must first move into the base of the other player. Then he or she must tap 5 times on the tablet in the base of the player whose flag they are trying to steal. This then sends a vibration notification to the player whose flag is being stolen. Once the player brings the other flag back to his base, the player whose flag was stolen is eliminated from the game. The last player remaining at the end of a round, wins the game.

To defend his or her flag, a player can take a couple of measures. Once their flag is stolen, a player can no longer steal another flag, but must go defend his or her own flag. To do this, the player essentially needs to run down the other player. If he or she hits against the other player who is carrying his or her flag, the flag is immediately returned to the base and the other player is stunned. To aid in catching a player, or escaping a player, each player can set traps using the volume controls on the smartphones. Although there is no limit to how many traps a player can place, there is a time interval after each placed trap before another can be placed. These traps stun the other players if run over, but will not affect the player that placed them.

## **Design Decisions and Results**

Throughout implementation and testing, there were several decisions made about how the game should be played, and how the user can interact with each of the devices.

### *Real Time vs Turn Based*

The game was initially intended to be a turn based game, allowing only one player to move and act at a time. The decision to switch from this initial set up to the real time game that was ultimately implemented was made in order to increase the engagement the players would need to have with the game. With a turn based game, only one player would even need to be near the tablet at a time to play. Since it did not facilitate engagement of all users both with their phones and the tablet, this style of play was not chosen.

### *Movement*

Several options were considered for the input method for player movement. Each of the options were considered and evaluated based on their ability to enhance user engagement, ease of use, and feasibility within the context of the game. The options considered were as follows:

1. With the camera focused on the tablet, the user then clicks on a location on the smartphone screen. The player will then move in the direction of the location that the touch is pressing in the game world.
2. Four buttons appear on the user's smartphone screen. Each button corresponds to a direction that the player can move in. These directions are relative to the view that the user sees with the augmented reality, so that the arrow pointing away from the user, will move the player away from the player as well.

3. With the camera focused on the tablet, the user can then focus the center of the camera to a particular location in the game world. The player will then move towards the location that the player is focusing on.



**Figure 3.** A player trying to move toward the upper left corner of the board using movement method 1.

The merits and drawbacks of each method were considered to ultimately choose the first option. The first and third options forced the user to interact with the game world, providing an inherent draw to the tablet that the second option did not possess. However, since the AR aspect did not always work perfectly, there are times in a game when a player may lose the tracking of the target on the tablet. In these cases, the third movement options is rendered useless, since the user cannot change his view of the screen. In addition, the user may want to move the phone away to interact with the tablet and force the player to move in an unwanted direction. Although the first option does not allow for perfect movement in these cases, some movement was still allowed while the user tried to recapture the target. The second option would

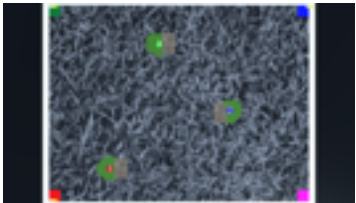
continue to allow movement in all directions even if the target was lost. In all three movement options, simply moving the smartphone or changing the view of the game, will affect the direction that the player moves if all other interactions remain the same.

Due to these reasons, the first option was chosen for this implementation of the game. However, further testing may need to be conducted to determine how well the different options test.

#### *Information Overload*

While trying to find ways for users to engage with the implemented game, testing revealed the real possibility of overloading the user with too much information. In order to move quickly, the user would have to keep the phone pointed at the tablet, click on the appropriate spot he or she wanted to head towards, and blow into the microphone. User feedback showed that while all of this was manageable, the addition of more features could very well make it too much for a player to handle in such a quick round.

With the issue of information overloading in mind, the trap feature was added. There were two options considered for traps being set during game play. The first option would allow the user to place the trap anywhere he or she had visible on the playing field. This would allow the user to place a trap someplace that no one else could see. The other players are totally unaware of the location of the trap being placed. To indicate where the user wants to place the trap, the user would have to be able to select the appropriate location while continuing to play the game. For this reason, the second option was chosen. The user simply has to press the button to release the trap at their current location. Although placing the trap at the current location allows the other players to see the trap



**Figure 4.** Screenshots from the tablet and the smartphone. The first shows three players on the tablet, where one is carrying the flag. The other shows the the green area and obstacles covered by the red player on the smartphone, information that is invisible on the tablet, as well as the 3D augmentation.

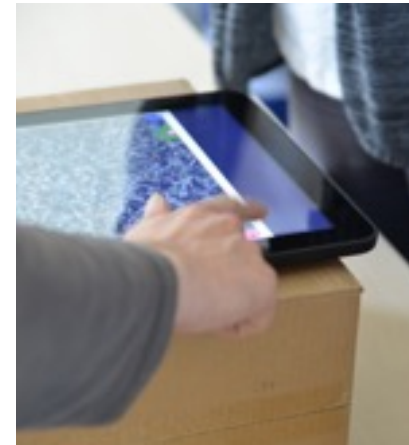
as soon as the player moves from the position, this disadvantage is negligible since players are often focused on other things and will not remember every location where a trap is placed.

#### *AR Component*

The AR component was included in an effort to draw the players to the tablet. A problem with the AR in the game scenario was that it was sometimes difficult to see. After initial testing, the tablet was moved closer to the level on which the smartphones were being held. This allowed the users to see the 3D augmentation over the 2D rendering on the tablet. Increasing the size of these objects and ensuring that the tablet is within a short distance of the smartphones would allow the features to be better seen by users, drawing them into the space.

#### *Tablet Interactions*

In order to create a game that used multiple devices but also created a feeling of interacting with one another that is often created with board games, interactions were distributed between the smartphones and the tablet. The tablet interactions (eg tapping to steal the flag) are used to draw attention to important events that users should pay attention to. Instead of sending a heads up notification to the players telling them that these important things were happening, the physical movement of players reaching across the table alerts them of this information. On the other hand, using the smartphone for movement allowed all players to move at the same time without confusion and using the volume controls to place traps was a subtle way to allow players to act without bringing attention to it.



**Figure 5:** A player attempting to steal the flag from the pink base by tapping on the tablet.

#### **Conclusion**

Capture the Flag was effective in being able to draw users into a space and force them to interact with each other as a multi-device Augmented Reality game. It uses each user's smartphone and an AR component to reveal a private space with information only available to a single user. However, the AR must be utilized in such a way that it does truly enhance the experience of the user and provide something additional to improve the user's gaming experience. There are still several options that were not implemented for the final Capture the Flag game, that can be tested in further iterations.

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