International Conference on Artificial Reality and Telexistence
Eurographics Symposium on Virtual Environments (2019)
Y. Kakehi and A. Hiyama (Editor)



# Augmented Dodgeball AR Viewer for Spectators

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**Abstract**

*These last few years many systems and methods have been developed to provide information to spectators about a sport game such as baseball, basketball, soccer, etc. Among them, Augmented Sport is one of the emerging area that intends to merge video game concept into physical sports. This project focuses on merging game elements such as Health Points (HP), Attack Power (AP) and Defense Power (DP) to improve enjoyment and variety of players. During Augmented Dodgeball games, the spectators can visualize via the Mixed Reality device additional parameters such as HP, AP and DP of each player. This data is superimposed onto each physical players by virtue of AR markers they wear. To avoid marker occlusion issues, fixed camera(s) are also used to inquire player's physical information and share it via a database. Studies have been conducted in order to find out the best displaying design, methods and limits of the system.*

**CCS Concepts**

• ***Human-centered computing*** → *Mixed / augmented reality;*

## 1. Introduction

Augmented Sport is a novel concept that merges video game concept onto physical sports. In more detail, several virtual characters are designed and have different virtual parameters such as Health Point (HP), Attack Power (AP) and Defense Power (DP). By choosing characters, players are assigned to virtual abilities according to each character. By designing virtual parameters and characters carefully, it can be used as a method for improving enjoyment, as well as a potential handicap system. Although a player is physically weak, the player can be a strong player if assigned parameters are high enough. We have developed Augmented Dodgeball, as a prototype of Augmented Sports and proved the effect of basic concept through a user study [4].

In dodgeball games, the players throw the ball on the opposite team players and must take care at the same time not to be hit themselves by a ball. In Augmented Dodgeball, players will lose HP if they are hit by a ball according to the thrower's AP and DP of the player who got hit. When a player loses all his HP, he gets out of the game.

One of the big issues of this Augmented Sport is that players and spectators are both unable to see those virtual parameters assigned to players. When watching traditional sports, lack of information may harm enjoyment of watching it. Augmented Sports have to handle more information than traditional one such as HP, AP and DP. They must be shown to spectators and players appropriately to help them to understand the situation smoothly. As a matter of fact, Augmented Dodgeball has a special scoreboard to show players' roles and HPs. However, it requires heavy recognition load to both players and spectators. They need to check a player's specific number, which is shown in bibs, then look for the number from the scoreboard. It takes a certain amount of time while the game is ongoing. In this paper, we especially focus on solving issues of spectators' side. In other words, we developed a display system for spectators that enables them to handle necessary information to understand ongoing game in front of them.

## 2. Related works

During sport games, remote spectators have more and more access to augmented information such as ball tracking, players positions, etc. Spectators present in the stadium have less access to information but these last few years some systems have been developed to deal with this problem and provide information to the spectators via smartphones or tablets [1] [2] [3]. Unfortunately, some of them need training for image recognition. Dodgeball is a casual sports. Thus, pre-process such as training players' visual information may not fit to such category of sports.

## 3. System

The issue during Augmented Dodgeball events is to provide to the attendance information related to virtual parameters, such as HP, AP and DP. Spectators should know all the information of the game. However, too much information may impair the understanding of the ongoing game and degrade the enjoyment. Thus, we choose to display minimum information that must always be shown during the game to be understandable. First of all, remaining HP is the most important information because it nearly equals to "how





DOI: 10.2312/egve.20191300

long the player can stay inside". In addition, character information is choosed to be displayed. Each character has different virtual parameters. Thus, character information can be used to guess how long a player may stay in the game. For example if a player is a Defender character, thanks to his good number of DP the spectators will expect the player to stay in the game longer. Indeed the player's defense ability indicated by DP prevents the Health Points from reducing. By this way it is really easy to follow the progress of the game and to inquire about the players state at the same time.

In this system, players are wearing chasubles with markers like in Figure 1. The camera fixed around the play field captures the frames during the game and these frames are treated and analyzed to calculate the players coordinates. Unity's Vuforia module is used to measure and deduce the position of the players. Once the coordinates are calculated, they are sent to a database. Spectators wear a MR device to see players' virtual parameters superimposed onto each players. The MR device can access to this database, collect the information about the players and integrates the HP and player character to the display. In this prototype, we use Hololens (Microsoft Corporation) as a MR device for spectators. For the communication among camera-database-Hololens the protocol TCP is used, and the camera-Hololens one is using UDP. Unity 5.6.3 has been used to develop the Hololens application. The structure of the system is illustrated Figure 1. The players' positions are captured by the camera, the coordinates are calculated and sent to the database and the players' status are deduced, sent and displayed on the spectator's device.

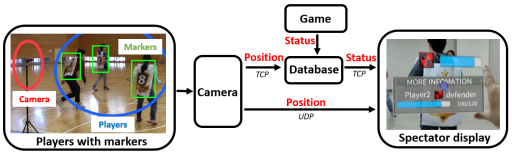


**Figure 1:** *Structure of the system*

As a result, a window is displayed on Hololens and the people in the audience can visualize the status of the players: remaining HP and player's character. The Figure 1 shows on the right part the displayed window when the user selects a player.

## 4. Evaluation

To optimize the system, experiments have been conducted to choose the communication protocol, the HP bar position and to determine the maximal workable distance player-camera but the main evaluation of this project consisted in asking to subjects to use the Hololens developed application, a smartphone with the same application as the one for Hololens and a Hacosco's virtual reality system and fill a questionnaire to compare the different methods and the efficiency of the system. This experiment has been conducted with 6 players (2 teams of 3 people) and 13 spectators. The spectators were asked to watch the game with one of the devices and change device after 2 or 3 minutes.

## 5. Results and discussion

It appeared that performing within a workable distance player-camera isn't enough to calculate efficiently the coordinates of the players. With a single camera we meet marker occlusion issues and the coordinates can't be calculated in some situations. Hololens is equipped of a camera and we know from experiment that the camera can recognize markers up to 5.9m distance, whereas conventional webcams such as Webcam C910 (Logitech) recognize the markers within a distance of only 3.1m. However it still wouldn't be enough to solve the problem since the players are performing on a 10m*5m field. Consequently it is necessary to use several cameras around the field to recognize the players' AR markers and to avoid occlusion. The method would be to merge the cameras' axis by using one standard AR marker fixed on the floor. The recognized position data would be captured, sent to the database and converted to Hololens coordinates.

Furthermore, according to the subjects Hololens app presented more delay than the smartphone or the VR ones. To increase the speed of the system UDP protocol should be applied to camera-database and database-Hololens communications too.

## 6. Conclusion

The aim of the project was to provide to Augmented Dodgeball spectators a way to visualize easily information about the players. The developed system meets the needs but according to the study, it should be improved to get more fluent and to be applicable to a larger field. The main conclusion of this project is about the information display. There are many display possibilities: design, material, etc. The study revealed that the best position of the players' information was on the shoulders of the players. Visualizing information merged to the environment is also an ideal method. However this method must improve in order to perfectly assist the spectators. To improve several cameras must be implemented to be able to detect and recognize the players on a larger field, without occlusion. In addition to this, if the speed can be improved by using UDP in the whole communication process for example it would be possible to apply the system to other sports and visualize other data such as players' movements, ball trajectories, etc.

## 7. References

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