

# ARHunter: A Multiplayer Game Using Gestural Input in a Location-Sensitive and Immersive Environment

**Koji Yatani Masanori Sugimoto**

Dept. of Frontier Informatics, University of Tokyo  
5-1-5, Kashihwanoha, Kashiwa,  
Chiba, 277-8561, Japan  
{yatani, sugi@itl.t.u-tokyo.ac.jp}

**Hirohichi Hashizume**

National Institute of Informatics  
2-1-2, Hitotsubashi, Chiyoda-ku,  
Tokyo, 103-8430, Japan  
has@nii.ac.jp

## ABSTRACT

By utilizing recent information and communication technologies, many researchers have been investigating studies on entertainment computing. In this paper, we propose an immersive entertainment environment combined with gestural input and location recognition technologies. Inertial sensors are used for recognizing players' gestures, and optical markers are used for recognizing players' locations and orientations. We have developed an entertainment application called ARHunter, which is a multi-player whack-a-mole like game. User studies of ARHunter indicated that it could enhance the level of players' engagement and excitement. Several issues to be investigated in our future work are discussed.

## Keywords

Immersive environment, gestural input, location recognition

## INTRODUCTION

One of the main purposes of entertainment computing is to develop entertainment technologies and applications that can raise the level of players' engagement and excitement. For this purpose, various types of interaction techniques and interactive environments for entertainment applications have been developed.

In this paper, we propose an entertainment application that has three major features: (1) By overlaying computer-generated graphics onto the real world, an immersive environment for playing a game is created; (2) Positions and orientations of multiple players moving around in the real world are used to affect a scenario of a game, and; (3) A player's gesture or action is captured and used as input to an application.

Various systems that utilize mixed reality technologies to enhance immersiveness [2] or those that implement positioning technologies to allow players to interact with real-world objects [1] have so far been proposed in the field of entertainment computing. In this paper, we integrate a gesture input technique with these existing technologies, in order to construct an entertainment application with more engagement and excitement.

A prototype application proposed in this paper called ARHunter is a multi-player (two players, in this study) whack-a-mole like game. In ARHunter, monsters are

displayed on a floor or a table through an LCD projector. Players are required to annihilate their own enemy monsters as soon as possible. Each player's actions and location are recognized by our developed device. He can strike a monster or sweep monsters away with the device, though monsters can escape from players when they get close to them.

## SYSTEM ARCHITECTURE

In ARHunter, we use the technologies developed for Toss-It [3] and an LCD projector installed to the ceiling. Each player holds a gesture recognition device (we call it a hammer in this paper). The hammer embeds inertial sensors and infrared (IR) LED. Each hammer is connected to a laptop computer which recognizes each player's actions with the outputs of the inertial sensors. These laptop computers are connected to the server computer through a wireless LAN. Although we place the computer at a fixed position in the current setting, a player may carry the computer on his shoulder, which makes the cable between the hammer and the computer more unobtrusive while a player plays ARHunter. A stereo camera is also installed to a ceiling so that it captures IR LEDs on each player's hammer to identify each player's location.

A server is used to generate monsters on a projected screen and move them around based on individual players' current positions. When a player conducts an action (swing vertically or horizontally) with his hammer, the laptop computer recognizes the action and sends the information to the server computer. The server judges whether the player strikes a monster successfully based on his action and position.

## HOW TO PLAY ARHunter

A player can strike a virtual monster by vertically swinging his hammer. When he correctly strikes a monster, the monster is killed. A player can sweep monsters away from a game arena by horizontally swinging his hammer. The time required for swept monsters to return to the game arena depends on how strongly and correctly a player have swept away them. When a player tries to strike or sweep monsters away, he brings his hammer close to them on the projected screen. ARHunter provides players with visual and auditory

feedback to let them know if they have successfully struck or swept monsters away.

In the current implementation of ARHunter, two players can play a game at the same time. We prepared two different modes: the match-up mode for competitive play and the tag-team mode for collaborative play, respectively.

In the match-up mode, each player is required to annihilate only his enemy monsters on the projected screen. A player has to strike a monster with his hammer twice in order to kill it. If a player kills a monster of the other player by mistake, the total number of his enemy monsters increases as a penalty. When a player approaches to monsters, they escape from the player in order not to be killed. A player wins the game when he has annihilated his all enemy monsters in the game arena faster than the other player.

In the tag-team mode, players are required to annihilate the enemy monsters on the projected screen collaboratively. In this mode, three different colored monsters appear: Blue-colored monsters move slowly and die by being struck twice. Yellow-colored monsters move a little more quickly than blue-colored monsters, and die by being struck three times. Red-colored monsters, which are the strongest ones, move most quickly and die by being struck five times. They win the game when players have annihilated all the enemy monsters in the game arena within a specified time-limit.

The time-limit is set to 100 seconds in both modes. If the time has run out, the game is regarded as a draw in the match-up mode and a lost in the tag-team mode. We prepared three stages for both modes. The time-limit is fixed through all three stages. When players advance to the next stage, the total number of the enemy monsters increases; therefore, the difficulty of the games increases.

## EXPERIMENTS & DISCUSSIONS

Informal user studies to evaluate the system were conducted. Four subjects (all male) were divided into two pairs and played the game in the match-up mode and the tag-team mode. Before each pair started to play the game, a brief introduction of the usage of the system and the rules of ARHunter was given. The feedback we received was overall very positive.

In the match-up mode, one player frequently interrupted another player with his arm or his body. Such physical interactions excited players to enhance their engagement. In another case, a player concealed the other player's monsters with his shadow caused by the light from the projector. Although a shadow on the projected screen is usually regarded as one of the major obtrusive factors for users, it is interesting that players could take advantage of the drawback of the system.

In the tag-team mode, players often divided the projected screen in order to efficiently exterminate their enemy monsters. For example, one player was responsible for

exterminating monsters that appear on the right half, and the other player on the left half. Although this kind of collaboration was effective for winning the game, it rather seemed to decrease the level of players' excitement, because assigning tasks to individual players separately reduces opportunities for their interactions. Therefore, the design of the tag-team mode should be examined.

## CONCLUSIONS & FUTURE WORKS

In this paper, we described an entertainment application called ARHunter, a multi-player game using gestural input in a location-sensitive and immersive environment. Informal user studies proved that ARHunter could raise the level of players' engagement and excitement by providing them with an athletic feeling and enhancing their physical interactions.

Several issues remain to be investigated. One of the significant issues is related to the design for collaborative play. As the user studies revealed, although a certain level of collaboration among players was observed, ARHunter could not support/enhance active interactions between them sufficiently. We will examine this issue from several viewpoints, for example, technologies for immersive game environments, gestural input and their integration, game scenarios, and roles of players. It is another critical issue for ubiquitous computing entertainment to enlarge a game arena of ARHunter (currently about 1.2 meters by 0.9 meters) and allow more than two players to participate in a game. We further plan to investigate in more details the opportunities of how we combine immersive environments with gestural input technologies in entertainment computing.

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## BIOGRAPHY

Koji Yatani is currently a first-year Ph.D. candidate at University of Tokyo. His research interest is mobile computing, entertainment computing, and CSCW.

Masanori Sugimoto is an associate professor at University of Tokyo. His research interest includes to HCI, especially mixed reality, mobile computing, and CSCW/CSCL.

Hiromichi Hashizume is a professor in National Institute of Informatics, Tokyo. His research interest includes human interface, wireless communication, and distributed processing.