

Ghost Hunter: A Handheld Augmented Reality Game System with Dynamic Environment

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Abstract. The progress of handheld devices has encouraged many researchers to make efforts to use handheld devices as an augmented reality platform. However, one of the important problems is a lack of immersion and reality due to small display. To overcome this problem, we introduce dynamic environment which consists of some movable structures and their controller that enable changes of virtual world to affect the real world. It has an effect on expanding the user's view limited by the small display of the handheld device. We have also developed the game content, 'Ghost Hunter', which is suitable for this platform.

Keywords: handheld augmented reality, dynamic environment, entertainment system.

1 Introduction

The technologies related to handheld devices have been developed rapidly in recent years, such as mobile phones, PDAs, portable game consoles and so on. These progresses have encouraged many researchers to make efforts to use handheld devices as an augmented reality platform [1], [2], [3], [4], [5]. It is called handheld augmented reality. Most handheld devices have a display and a camera. Those are convenient for carrying, and don't bother people like HMD so they are suitable for augmented reality. However, one of the important problems with it is a lack of immersion and reality compared with other augmented reality system due to small display of handheld devices.

To overcome this problem, we introduce dynamic environment which consists of some movable structures, and their controller that enable changes of virtual world to affect the real world. For example, the warning light could be turned on or the miniaturized building with a motor could move for representing the movements of the virtual world. It would expand the user's view limited by small display of devices into the real world beyond small display. We have also developed the game content, 'Ghost Hunter', which is suitable for a handheld augmented reality game system with dynamic environment.

2 A Handheld Augmented Reality Game System with Dynamic Environment

2.1 Dynamic Environment

As stated above, dynamic environment is the operating structures which allow the virtual world to have an effect on the real world. A user can easily see the outside of the display because most handheld devices just have small displays. For a user who plays a normal computer game, seeing outside of the display will break the immersed mood because the outside contains nothing related to the game. However, if there are some events related to the game in the outside of the display, the real world can become a part of the game (Fig 1).

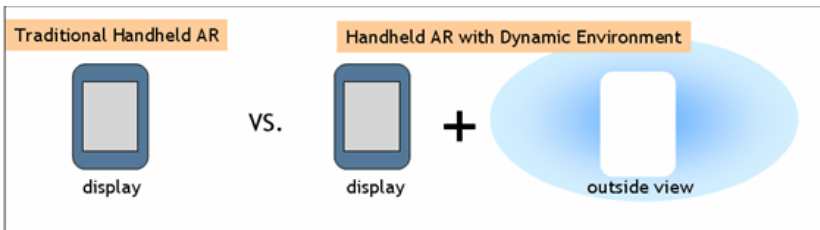


Fig. 1. Introduction of dynamic environment

Dynamic environment leads to a new experience beyond the limitation of small display of handheld devices. Such a new interaction immerse people in the game and increase the reality of the game.

2.2 Interactions in Dynamic Environment

In this research, we called the real world of traditional augmented systems as 'Static Environment'. Interaction between real world and virtual world in static environment just occurred by events in real world such as moving control markers. In this type of interaction, events in the real world affect some movement of virtual world, but the reverse process is impossible. That is a one-way interaction.

Compared with it, dynamic environment supports the interaction in static environment and above that, it is possible that events in virtual world can affect some movements of the real world. That is a two-way interaction. Dynamic environment enables a player to understand the state of virtual world more directly because it is able to represent virtual information by some movements in the real world such as turning on the warning light or operating the miniaturized building according to the movements of the virtual world.

3 Ghost Hunter

3.1 Scenario

One of the main characteristics of augmented reality is that while something is invisible through the naked eye, it is visible through a display device for augmented reality. So a handheld device plays a role such as 'Magic Lens', and that point became a motive of 'Ghost Hunter', the handheld augmented reality game that a player eliminates invisible ghosts which can be seen through AR Gun (Fig. 2. (left)).

We designed a miniaturized town like the Fig. 2 (right). Ghosts come out through tombs of the town. A game player can know that ghosts might exist in the town as seeing the opened tomb, but can't see ghosts through the naked eye. The player can take aim at and eliminate the detected ghost by AR Gun. If there exists a ghost which have intention of attack the player, the warning light which is closest to the ghost would be turned on, so the player becomes aware of the existence of the dangerous ghost. In Ghost Hunter, the tombs with the moving lid and the warning lights are dynamic environments which reflect changes in virtual world. Fig. 3 shows a user enjoying the ghost hunter game and the screen of AR Gun.

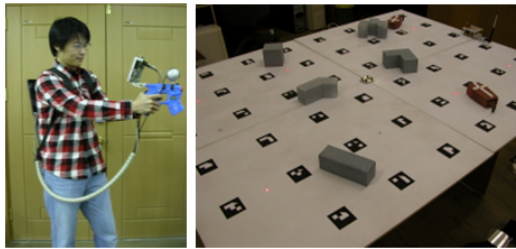


Fig. 2. (left) AR Gun and (right) Miniaturized Town

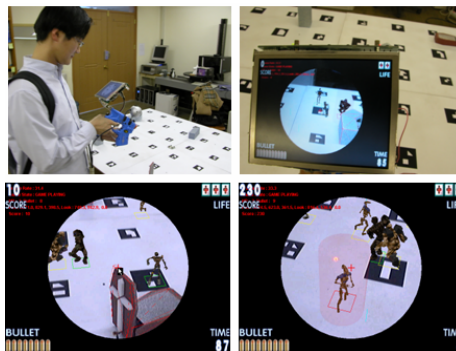


Fig. 3. Ghost Hunter

3.2 System Configuration

The fig. 4 represents the system configuration of Ghost Hunter. There are several miniaturized buildings, 3 tombs, and 8 warning lights on the game board (160cm x 120cm) with markers. The player enjoying Ghost Hunter wears the wearable computer connected to the AR Gun. The dynamic environment controller attached to the game board communicates with the wearable computer by blue-tooth wireless networking and controls dynamic environments such as the tombs and the warning lights.

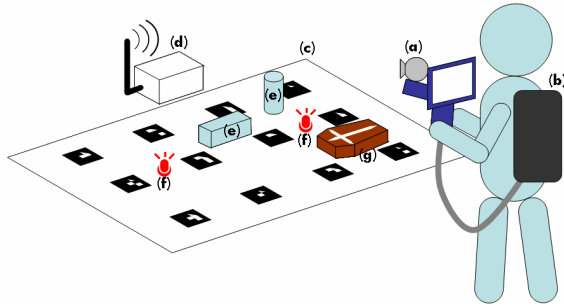


Fig. 4. System Configuration, (a)AR Gun, (b)Wearable Computer, (c)Game Board, (d)D.E. Controller, (e)Miniaturized Buildings, (f) Warning Lights, (g) Tomb

3.2.1 AR Gun

This research originally aimed at the development of an augmented reality game system suitable for handheld devices. It is difficult, however, to use pure handheld devices such as mobile phones and PDAs due to the performance limit. Therefore, we use the platform which consists of the AR Gun and the wearable computer like the fig. 5 instead of the mobile phone with a camera. Our platform has something in common with the latest mobile camera phone: a small display device, a camera, some buttons, the blue-tooth communication system, and the portability.

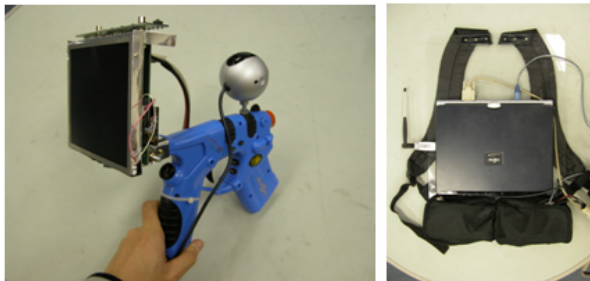


Fig. 5. (left)AR Gun and (right)Wearable Computer

3.2.2 Game Board and Map Editing Process

The game board is a background of the game like worlds of other computer games. The miniaturized buildings and tombs lay on the game board, and Ghosts move avoiding them. The markers are arranged at intervals of 20cm on the game board to calculate the pose with 6 degrees of freedom (3 for translation and 3 for rotation) of AR Gun.

The player can customize the positions of the buildings and the tombs through the map editing process that helps to avoid the monotonousness coming from the fixed arrangement of the miniaturized buildings and tombs. The pads with the same shapes of the bottom shapes of the buildings are used in the map editing process. The pads have their own marker to calculate the pose with 3 degrees of freedom (2 for translation and 1 for rotation) on the game board. After the map editing process, 3D CAD models of the buildings and the tombs are aligned with the real ones, and ghosts can hide themselves behind and avoid collisions with the buildings (Fig. 6).

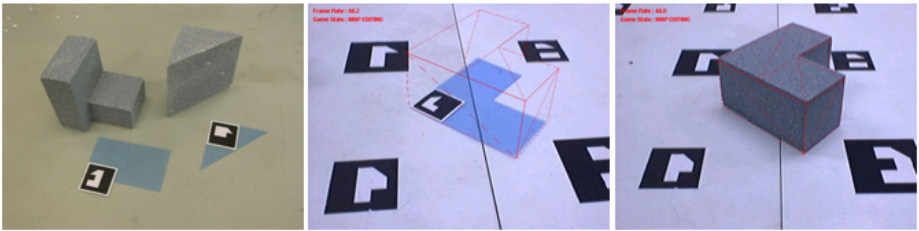


Fig. 6. Map Editing Process

3.2.3 Dynamic Environment Component and Controller

Dynamic environment components and their controller receive the events which are occurred by the changes in the virtual world, and represent it in the real world. Dynamic environment components may consist of various output devices such as motors, lamps, speakers, robots, and so forth. In Ghost Hunter, two types of dynamic environment component are used: RC-servo motors and LEDs. RC-servo motors are used in the tombs, and LEDs are used in the warning lights. The controller which controls dynamic environment components consists of a micro-controller and a bluetooth module (Fig. 7).

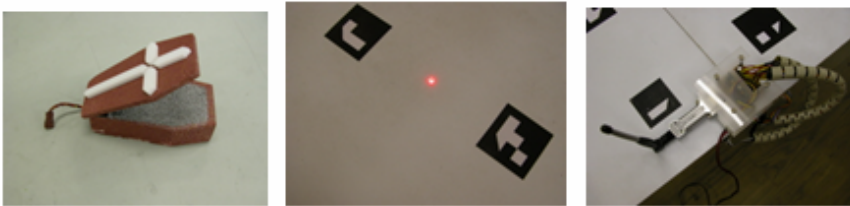


Fig. 7. (left)Tomb, (center)Warning lights, (right)Controller

4 Conclusion

A handheld augmented reality system has less immersion and reality compared to other augmented reality systems due to its small display. To overcome this problem, we introduced dynamic environment, which has effects on real world from the changes in the virtual world. We expect a player to interact with the changing real world over the boundary of the small display of handheld device and feel more immersion and reality.

Through the research, we have developed 'Ghost Hunter', the game content suitable for a handheld augmented reality game system with dynamic environment such as the tombs with the moving lid and the warning lights. In Ghost Hunter, the positions of the miniaturized buildings are customized through map editing process to reduce monotonousness, and game characters are able to interact with the miniaturized buildings aligned with 3D CAD models.

As a result of a user study, we found out that the introduction of dynamic environment in a handheld augmented reality helped players feel more reality and enjoyment.

In the future, the system will be used actively in theme parks or amusement halls. The players will hold their own mobile phones or special handheld devices and enjoy our system. We think that it has strong potential to contribute for amusement of modern people who want more realistic and tangible games.

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