

Augmented Reality Card Game based on User-specific Information Control

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ABSTRACT

In this paper, we describe new way to use augmented reality (AR) for entertainment. AR is a technology that overlays virtual objects on real objects in real world as a natural and intuitive interface. We think AR also can provide multiple users with different sight in real world and control information displayed for each user. We use these AR features for entertainment to present another enjoyment for users. As an example of our proposal, we implemented a card game system and evaluated it to examine usefulness of our concept for entertainment.

Categories and Subject Descriptors

D.5.2 [Information interfaces and presentation]: User Interfaces – Graphical user interfaces. H.5.1 [Multimedia Information System]: Artificial, augmented, and virtual realities. K.8.0 [Personal Computing]: General – Games.

General Terms

Design, Human Factors

Keywords

augmented reality, entertainment computing, game design, card game, user-specific information control

1. INTRODUCTION

Nowadays, augmented reality (AR) is used actively for entertainment and it is increasingly important to study useful AR essences for entertainment. Entertainment computing area is expected to establish and systematize how to implement good contents. Our purpose is to present new AR essence useful for entertainment.

There are several differences between AR and real world. AR world exists in vision of each user and adds digital information to physical realities that the users are look at. The digital information

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can be changed its contents artificially. That is to say, AR allows multiple users to get the information individually and selectively even if they look at the same physical reality. Our proposal is to apply the features of AR to entertainment. As an example of our concept, we implement a card game system. This system has the potential to provide users with new enjoyment by user-specific information control.

2. OUR CONCEPT

2.1 User-specific Information Control

Figure 1 illustrates our concept. In Figure 1, two players are looking at a same physical card. If ♥10 is displayed on the card by AR, ♥10 is shown for the both players in usual AR applications. In our concept, information controlled according to a certain context in card games is displayed individually. To control includes the meanings of adjustment, limiting and adding etc. The context in card games means phase of a game and win-or-lose factors like power gap. In our concept, AR shows ♥10 as complete information for one player and some sort of symbolic expressions as incomplete information for the other player. For example, the expression indicates that the number on the card is higher or lower than a certain threshold. In Figure 1, because the card number is higher than the threshold ♥8, the word “High” is shown.

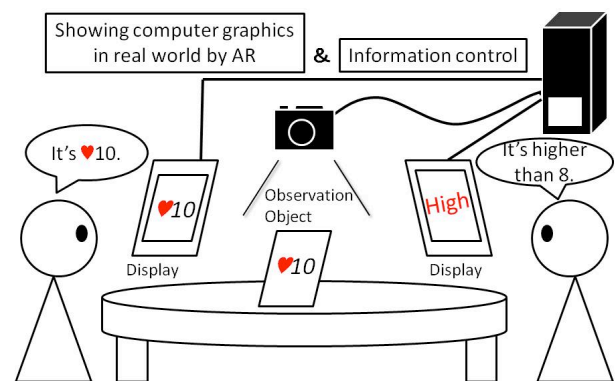


Figure 1. User-specific view and information control.

Several studies and products relate to AR card games. Okada, et al. provide the users with game instructions by AR [1] [2]. The Eye of Judgment [3] uses AR to visualize the characters and effects on the cards. Lam et al. [4] provide 3D graphics and sound enhancement to visualize and realize the trading card game.

Katayose et al. [5] show the monsters and battles on the players' arms. To wrap up, existing AR card games use visual rendition effects, sound enhancement and information assists functions of AR to give enjoyment for users. They do not use the user-specific information control like our concept.

Many of AR games have the multiple users look at the same virtual objects [6] [7]. We have the users look at the different virtual objects. Wetzel et al. [8] present the 12 guidelines for designing AR games. Those guidelines do not advise from the point like our concept (user-specific view and information control). Our concept has the possible of novel idea for AR game design.

2.2 Manipulation for Playing Cards in AR

We have the users operate playing cards by natural and intuitive manipulation techniques in AR. Therefore, we use affordance of physical objects. Importance of affordance for realizing natural and intuitive manipulation is discussed in the paper [9]. We prepare the physical papers as our playing cards. They are similar in size to general playing cards. The digital information is shown on a card itself. In this way, the users can control them in the same manner as the typical real playing cards: turning up, touching, shuffling, and using with the physical coins etc.

3. OUR AR CARD GAME

3.1 What is Concentration Game?

We implement concentration game as an example of our concept. In this paper, we call it AR concentration game. This game is extended from Japanese typical concentration game in playing cards game. In the rules of the concentration game, players lay all cards face down. Players turn up two cards in turns. If a player turns up two cards with the same number, a score is given for the player and the player turns up the other cards continuously. When a player turns up two cards, all players can look at their number. The players need to memorize the card numbers and positions. In general, players who have concentration and memory skills are more successful.

3.2 System Architecture and Playing Cards

Figure 2 illustrates our system architecture. We use ARToolKit [10] as programming library for creation of AR system. The number of players in our game is temporarily two people. Our playing cards are made from a little hard paper. Their sizes are about 9cm × 6.5cm. We stick ARToolKit markers on both sides of the papers. We call them AR cards. In Figure 2, the left window shows AR cards with clue (In other words, hint.) to support user A and the right window shows AR cards without clue for user B. The detail of clue is explained in section 3.3.

The markers of AR cards have the potential to induce players' hopes that our game is special card game. Hence, we use not markerless but marker tracking technology purposely. If players memorize the correspondence between the patterns of markers and information displayed, they would not get enjoyment of concentration game. Therefore, we make the patterns that are hard to remember for a person by using the web site [11]. Our policy for markers is also different from it by Okada et al. [1] [2]. They use the card numbers and suits as the patterns of their markers.

3.3 AR Concentration Game

As noted before, in the concentration game, players who have concentration and memory skills are more successful. Our application gives visual clues about the card numbers and position

for specified players (Figure 3). This allows the players to think things to do for victory with seeing the clue displayed in their view.

A first clue shows an arrow at back of a card (see the top picture of Figure 3). The arrow indicates that the card number is higher and lower than a certain threshold. The arrow supports to memorize the number symbols of all cards. We call this clue Number-Clue. A card number is a part of the card property. We call clue about the card property Property-Clue. So to speak, Number-Clue is a part of Property-Clue (Figure 4).

A second clue shows a red frame at back of a card (see the bottom-left picture of Figure 3). The frame indicates that somebody turned up. Players often turn up a card located next to correct card. This is because they sometimes memorize cards' position incorrectly. The frame supports to memorize the position of the card. We call this clue Position-Clue. A card position is a part of operation history done for the card by players. We call clue about the operation Operation-Clue. So to speak, Position-Clue is a part of Operation-Clue (Figure 4).

A third clue shows arrows for the cards that somebody turned up (see the bottom-right picture of Figure 3). This clue is crossover between Position-Clue and Number-Clue (Figure 4). That is to say, this clue supports to memorize both the card positions and numbers.

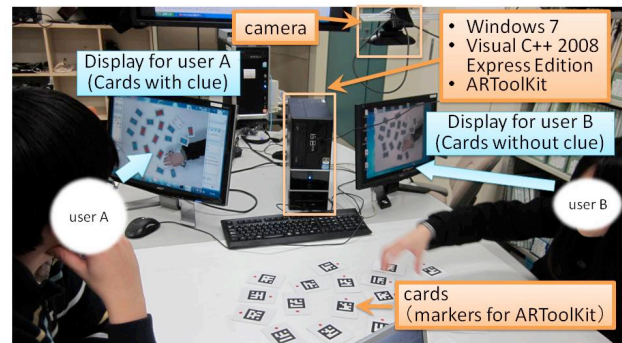


Figure 2. System architecture.

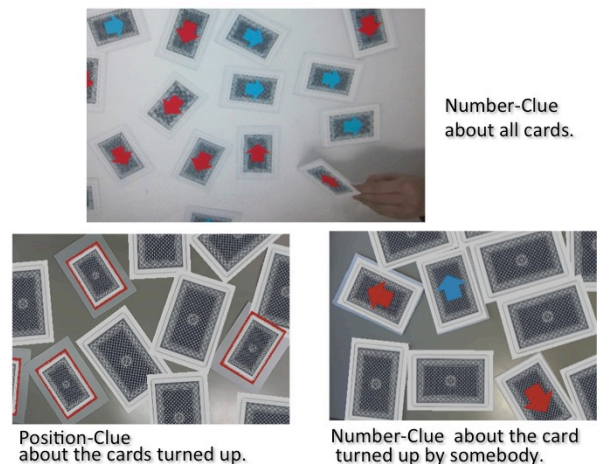


Figure 3. Clue examples of AR concentration game.

3.4 Various Developments of Clues

To control opportunities for providing these clues and add noise to them produce various plays as shown in Figure 4. We explain several examples.

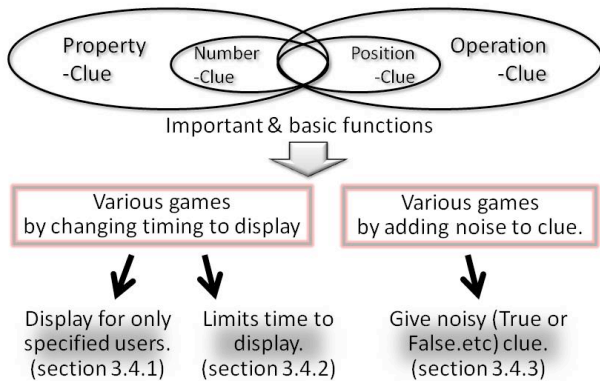


Figure 4. Various developments of clues.

3.4.1 Display for only specified users

If clue remains be displayed at back of the cards for only specified player during a game, the clue helps the player to memorize the number and position. This function can even up memory skills. Victory or defeat in concentration game depends on the concentration and memory skills. Victory or defeat in “old maid game” tends to strongly depend on luck. Thus, concentration game is different from games such as “old maid game”. According to Caillois [12], luck is one of important elements in play. To give a clue in concentration game would enhance luck relatively as a game element and give more enjoyment.

3.4.2 Limiting time to display clues

If the opportunity for giving a clue is limited, the clue sometimes prevents the players from success and supports them. For example, while a player is turning up a card, only arrows as a clue are displayed for another player. In this rule, the players can know the card number only while the card is turned up by his / herself. Besides, if a player takes a long time for the card choice, a certain clue is displayed for another player. Besides, if a player gets scores continuously, a certain clue is displayed for another player, and so on.

3.4.3 Giving noisy clues

If the noise is added to the clues, the clue sometimes prevents the players from success. For example, giving false clue for the players confuse them. If a player can control the opportunity for giving these clues for the other player, the player has game plan. Because victory or defeat in concentration game depend on concentration and memory skills, the game does not need game plan as an element of play. For that reason, giving noisy clues can change the game into new play.

4. USER STUDY

4.1 Experimental Procedure

The purpose of this experiment is to examine usefulness of our concept for entertainment. Our concept is to control information individually on the context and display in real world.

The number of the cards is 24. The procedure is described below.

1. We explain the rules of the concentration game.

2. Subjects play a game by using conventional playing cards.
3. Subjects play a general web game by using mouse operation.
4. Subjects play two AR concentration games on our system (see Figure 2). The following clues are displayed at back of all cards for only specified subject during a game:
 - A) Number-Clue: We show the arrows indicate that the card number is higher or lower than eight. A blue arrow shows 7 or less and a red arrow shows 8 or more.
 - B) Position-Clue: We show the red frames to indicate that somebody turned up the card.
5. Subjects return our questionnaires.

The purpose of step 2, 3 and 4 is to compare enjoyment. In step 2 and 3, we also examine defeated subjects. In step 4, Number-Clue and Position-Clue support the defeated subjects. In step 2, 3 and 4, we examine how many cards that the subjects get. In step 5, the questionnaires are as follow.

- (1) Please evaluate enjoyment of our system in 7 levels about Number-Clue and Position-Clue. Here, enjoyment value of games by the real playing cards is 4.
- (2) What do you think is fun with our system in the question (1)? This question is free description.
- (3) Please evaluate enjoyment of our system in 7 levels. Here, enjoyment value of web games by mouse operation is 4.
- (4) What do you think is fun with our system in the question (3)? This question is multiple-choice.
- (5) What do you think is fun with our system throughout the whole experiment? This question is multiple-choice.
- (6) Please write your perceptions and impressions, etc. This question is free description.

4.2 Results and Discussion

We analyzed 14 subjects’ data. The subjects are all students and close in age. This is similar to the situation where people have conventional card games in our daily life.

4.2.1 Effects of the clues to support memory

Figure 5 presents the numbers of the cards that the subjects got.

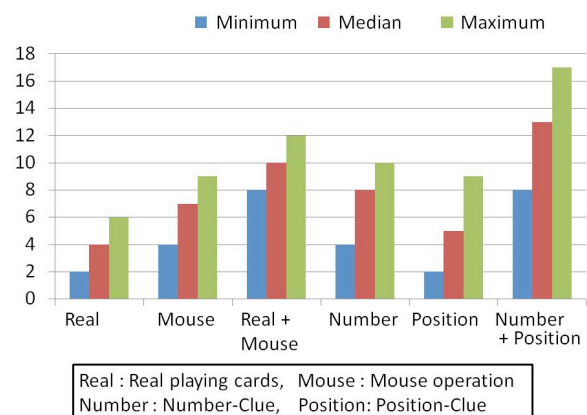


Figure 5. The number of the cards that the subjects got.

In Figure 5, the number of cards that subjects got on our system is more than it by using the real playing cards or mouse operation. In addition, the number of cards by Number-Clue is more than it by

Position-Clue. We checked subjects' opinions on this point. Subjects answered fun things about Number-Clue as follows:

- I could get scores easily because the clue remained useful during a game.
- A combination of the arrows with the same color held the potential to share the same card number. Therefore, a combination to turn up was limited and I could win easily.
- I could memorize and play easily.

These opinions and Figure 5 suggest that Number-Clue is useful. Number-Clue has potential to enhance luck relatively as a game element. Subjects answered fun things about Position-Clue as follows:

- The clue was suitable for me. It gave enjoyment for me.
- The clue did not remain useful during a game. When we turned up all cards, it made no sense to show a red frame.

These opinions and Figure 5 suggest that Position-Clue is not very useful.

4.2.2 Enjoyment of our system

Figure 6 presents enjoyment of our system.

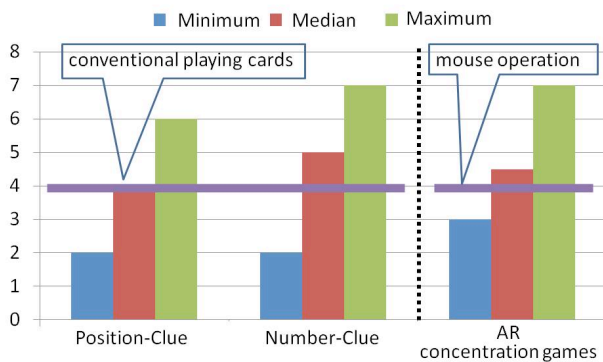


Figure 6. Enjoyment of our system.

In Figure 6, enjoyment of our system is more than it by using the real playing cards or mouse operation. However, score about Position-Clue is slightly lower than Number-Clue. Maybe, this would be because Position-Clue was not very useful for subjects. To give the clues individually can be realized by controlling information displayed individually. Therefore, the clues have to give enjoyment that conventional concentration games does not. We checked subjects' opinions on this point. Subjects answered fun things about Number-Clue as follows:

- The game was exciting because of the clues. It gave enjoyment for me.
- The other player turned up a card incorrectly. It could be seen from my view. It gave enjoyment for me.

To the question "What do you think is fun with our system throughout the whole experiment?" 9 subjects chose clues.

These opinions and Figure 6 suggest that our clues are useful. Thus, this fact suggests that controlling information displayed individually for card game is useful.

4.2.3 Effects of AR cards

To the question, "What do you think is fun with our system in the question (3)?" 11 subjects chose "To turn up a card," or / and "To

touch a card." To turn up or touch a card was realized by the physical life-sized card. This fact suggests that the card is useful.

And also, there was an opinion like this: "The cards did not tell the card number by only looking at. It gave enjoyment for me." In our interpretation, this fact suggests that our marker that is hard to remember is useful.

5. CONCLUSION AND FUTURE WORKS

In this paper, we focused on the benefits that AR shows digital information in real world and controls the information individually. We implemented new game utilizing these AR features. User study suggested that these AR features are useful for entertainment.

Definition and classification of play is important in entertainment computing area. Our system can be defined as new play. Hence, we will discuss in more detail through additional user studies and knowledge about play. And also, we will implement the other AR applications by using user-specific information control.

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