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RANTORE: A Strategic Exertainment System Using Location Information

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Abstract

We propose RANTORE, a strategic exertainment (exercise + entertainment) system that uses outdoor Global Positioning System (GPS) location information to promote exercise. Similar to a treasure hunt, the RANTORE system encourages players to move around an outdoor area to collect virtual treasures and coordinate with other players in a fun, outdoor activity. Our evaluation experiments reveal that the exercise was not strenuous, but the game did promote exercise. In addition, the entertainment aspects and continuity of the exercise were evaluated to be high, even when players played the game several times, because the game kept them engaged.

1. Introduction

Various body movement sensors have been developed in the last few years, and the devices that use them have diffused rapidly because they are easy to operate. For example, games that exercise the entire body such as the Wii Fit Plus [1] or Kinect [2] have become immensely popular because they make exercise pleasurable. This field, which combines both entertainment and exercise, is called exertainment (exercise + entertainment) [3]. However, such systems are generally confined to indoor environments.

We propose RANTORE, a strategic exertainment system that uses outdoor Global Positioning System (GPS) location information. This system aims for outdoor, fun exercise. Similar to a treasure hunt, users locate and collect virtual treasures, and can negotiate with other users to earn points and secure land. The system
includes four strategic functions: acquisition, realization, negotiation, and joint land ownership. We designed the game so that users will not get too tired even if they play it many times.

2. Related work

Several games already exist that use GPS location information. The following examples specifically relate to our study. Colors [4] is a game about a street gang war. A player’s position becomes the stage of the game. Players can face each other using Bluetooth communication, and it includes a messaging function. “Can You See Me Now?” [5] is a chase game consisting of online players and one runner who actually walks around a downtown area. The runner uses the GPS to send position information, and a chat communication is also possible. This game does not include a cooperative function between runners. METAL GEAR SOLID PORTABLE OPS [6] is a famous battle game. The game uses a wireless local area network (LAN) and can get a soldier. The games mainly use GPS as a parameter for making groups. This game has a communication function. Cooperative treasure hunt [7], a virtual treasure hunt, uses location information and contains character avatars. The participants compete for points by searching for virtual treasure. This game is an example of the “fighting type” of treasure hunt game. The participants must cooperate in real time to locate the treasure, some of which cannot be obtained without cooperation. From the experiments the following points became clear that participants evaluated highly the avatar operation system that used GPS location information. Moreover, the operation by this avatar made it clear that working raises the sense of presence of the game. The cooperation system by which each player’s position became a point allowed location information to be used well.

Wii Fit Plus [1] is an extension of Wii Fit; both are exclusively used with the Nintendo Wii gaming console. Players play using the Wii balance board, which is the board-shaped controller that includes four built-in strain gauge force sensors. Players stand on a board and move their entire body to operate it while attempting to maintain balance or follow the instructions on the screen. Wii Fit Plus includes various exercises and additional functions such as setting the training menu, a calories-out indication function, and an exercise record.

Microsoft Kinect [2] is a motion gaming device that tracks users’ body movements without using a controller; gesture and sound recognition allow intuitive and natural play. Kinect Sports is a game that lets users play soccer, beach volleyball, bowling, field-and-track events, boxing, or table tennis using their entire body. The system provides single and cooperative play for up to four users at a time. Each player’s movement is linked to an avatar on the screen.

3. RANTORE system

We named our proposed exertainment system RANTORE as a combination of the abbreviations of the terms “treasure (tore)” and “land (Ran),” because the game includes the elements of both treasure hunting and land acquisition. In addition, from the viewpoint of exercise, RANTORE involves both “running (Ran)” and “training (tore).”

3.1. Design policy

(1) Game played by real humans
When the opponent is not a human being (e.g., bots), the overall motivation toward the game becomes low. Conversely, when the game is played by multiple real players (i.e., human beings), it becomes more interesting than in the former case.

(2) Game that maintains the strategy characteristics
Based on the results of our former research, it was determined that retaining the strategy characteristic of
players was imperative in GPS games (the Electronic Playing Tag) [8]. If strategy characteristics do not exist, the game can be disappointing in a multiplayer environment.

(3) Game that provides feedback on the amount of exercise performed

In the previous version of our treasure hunt game, cooperative treasure hunt, the momentum of players was not calculated [7]. Hence, in this implementation, we ensured momentum calculation.

(4) Game that maintains continuity

If exercise is not continuous, it becomes ineffective. However, maintaining continuity is also considerably difficult.

3.2. System configuration

The RANTORE system consists of a server and clients. A client consists of a tablet PC (Windows OS), a cellphone unit (b-mobile), and a GPS unit. The programming language used was Visual C#. The system contains approximately 3,500 lines of program on a client and 900 lines of program on the server. Table 1 shows the client details.

Table 1. Client details

<table>
<thead>
<tr>
<th>Tablet PC</th>
<th>Screen size (inch)</th>
<th>Weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LaVie-Touch LT550/FS(NEC)</td>
<td>10.1</td>
<td>730</td>
</tr>
<tr>
<td>TW317A7(ONKYO)</td>
<td>11.6</td>
<td>1000</td>
</tr>
<tr>
<td>VilivX70(BRULE)</td>
<td>7</td>
<td>660</td>
</tr>
</tbody>
</table>

3.3. Game summary

RANTORE is a multiplayer treasure hunt game that uses real-time two-way communication and GPS-based location information. The purpose of the game from the players’ perspective is to acquire more points (score) higher than the other players. There are three ways to acquire points:

(1) redeeming treasure acquired
(2) sharing land with other players
(3) moving

In method (1), players earn points for redeeming a virtual treasure found. In method (2), they gain points when they work with other players to acquire land. In method (3), they acquire points by moving around. Players must perform these actions within a specified time limit, and the winner is the player with the highest score at the end of the time limit.

3.4. Basic function of system

There are four primary functions of the game: treasure acquisition, treasure redemption, negotiation, and joint land ownership.

(1) Treasure acquisition

Players acquire treasure by moving to the location of the treasure specified by the map on their screen (Fig 1) and then clicking the acquire treasure button. The status screen, shown in Fig 2, displays all the treasure acquired by a player. The player can obtain no more than three units of treasure. To continue acquiring treasure, players can (1) throw away treasure, (2) redeem treasure (in exchange for points), and (3) give treasure to
another player using the negotiation function.

The status screen also displays information about the treasure, all the players (including oneself), war situation history, distance moved, and scores. In addition, a player can also destroy or exchange treasure, negotiate (explained later), and own land jointly using various functions on the status screen. The current player’s number is underlined on the status screen; Fig 2 shows that this device belongs to Player 2.

(2) Treasure redemption

To redeem treasure for points, a player must walk to the redemption location, indicated by the rectangle in Fig 1 to realize treasure. The points acquired through this redemption are added to the score of the player (700 points have been added for Player 2 as shown in Fig 2). The points are doubled if the color of the treasure matches that of the player. In Figure 2 the second line of treasure and player 2 are shown the same color.

(3) Negotiation

The negotiate function allows players to exchange treasure or points with other players. Fig 3 shows the condition when there is another player nearby who wants to negotiate. In Fig 3, the cat avatar comes in contact with the fox avatar, and the negotiations are enabled if only these two people are present. However, in this case, negotiations are not possible because they are separated by the penguin avatar. We determine that the players come in contact if their coordinates on the x-axis and y-axis are within 40 pixels (approximately 10 m) of each
other. Because the avatars are $40 \times 40$ pixels, we consider that players come into contact if their avatars are next to each other on the map.

When a player wants to negotiate, he/she chooses the radio button in the player column of the status screen of another player and clicks the negotiate button (Fig 2). Then, a negotiation screen (Fig 4) is displayed. Treasure-to-treasure, treasure-to-points, and points-to-points negotiations are possible. A player chooses one's treasure and the treasure of the partner or a point and then pushes the OK button. Then the negotiations are concluded. Players conduct negotiations on a single terminal (tablet PC); that is, the two people meet, one initiates the negotiation screen, and they decide while watching the same screen.

![Fig. 3. Negotiation between the fox avatar and the cat avatar](image)

The points are doubled if the color of the treasure matches that of the player. For example, Player A might collect a treasure worth 800 points. However, that same treasure might earn 1,600 points for Player B. Therefore, Player B can offer to buy that treasure from player A for 1,000 points by negotiation. In this transaction, Player A effectively earns 200 additional points for the treasure when he/she transfers it to Player B; Player B effectively saves 600 points.

(4) Joint land ownership

The joint land ownership function involves acquiring an area in cooperation with another player. We call the sections divided into a constant size in a map an “area” (Fig 5). Players accrue points by acquiring land. Similar to negotiation, the collaborators must be physically present near each other.

Players can choose their collaborators from the status screen (Fig 2) by clicking on the acquire land button (Fig 2) at approximately at the same time. A message is displayed on the screens of both collaborators when an area is acquired, and it is displayed in the war situation history (Fig 2). The war situation history displays only the two collaborators who acquired the area. The areas that collaborators acquire belong only to themselves, and the score is distributed between the two players equally. In addition, joint ownership is possible even for areas that were acquired previously. In this case, the new owners of the area become the two people who most recently collaborated. The same player can acquire the same area many times. For example, Players B and C can acquire the area that Players A and B had acquired previously. In this case, Player A is robbed of the area. Players can view the area(s) acquired by other players using the player information screen, which is shown in Fig 5. In addition, one area adds 500 points to a player’s score. We show the result screen of a trial in Fig 6.
The points acquired by a player are the total of the points accrued by treasure redemption, distance moved, and total area acquired.

![Player information screen](image1)

**Fig. 5. Player information screen**

![Result screen](image2)

**Fig. 6. Result screen**

3.5. **Strategy characteristic and exercise promoted by each function**

We summarize the strategy characteristic and the exercise promoted by the four main functions of this system in Table 2. We dispersed the treasure at varied locations throughout the map at the start of the game. Thus, players had to apply strain to reach locations, promoting unconscious exercise. To redeem the treasure, players had to move to the redemption location; this again promoted exercise. Further, it also promoted inter-player communication, as the redemption location became a common place of gathering. For both negotiation as well as joint land ownership, it is necessary for two players to collaborate. Hence, moving to the location of the other player becomes necessary, and communication is also promoted.
Table 2. Strategy characteristic and exercise promoted by four main functions

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Exercise promoted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treasure acquisition</td>
<td>Collect a large amount of treasure</td>
</tr>
<tr>
<td></td>
<td>Move to the location of the treasure</td>
</tr>
<tr>
<td>Treasure redemption</td>
<td>Redeem treasure in lieu of points</td>
</tr>
<tr>
<td></td>
<td>Move to the redemption location</td>
</tr>
<tr>
<td>Negotiation</td>
<td>Trade to gain advantage</td>
</tr>
<tr>
<td></td>
<td>Move to the location of the negotiation partner</td>
</tr>
<tr>
<td>Joint land ownership</td>
<td>Acquire more land</td>
</tr>
<tr>
<td></td>
<td>Move to the location of the collaborator</td>
</tr>
</tbody>
</table>

4. Experiments and discussion

4.1. Experiments

The experiments were conducted in the Wakayama University premises, and the experiments were conducted five times. Four people participated in each experiment, and players used different tablet PCs each time. Players carried out only the first and second experiment for 40 minutes. Treasure revives in remainder 10 minutes. They carried out three times of remaining experiments for 30 minutes. Treasure revives in remainder 15 minutes. A questionnaire was provided at the end of each experiment. Fig 7 shows the experiment screen of our system.
4.2. Results of experiments

Table 3 shows the quantitative results of our experiments. Table 4 shows the results of the questionnaire using a five-point evaluation. In Table 4, some results of Q6 are shown in “-“. This shows that there was not negotiation. Table 5 shows the usability of each tablet PCs using a five-point evaluation.

### Table 3. Quantitative results of experiments

<table>
<thead>
<tr>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average distance moved [m]</td>
</tr>
<tr>
<td>Average number redemptions</td>
</tr>
<tr>
<td>Average number of negotiations</td>
</tr>
<tr>
<td>Average number of joint land ownerships</td>
</tr>
</tbody>
</table>

### Table 4. Results of questionnaire

<table>
<thead>
<tr>
<th></th>
<th>1st</th>
<th>2nd</th>
<th>3rd</th>
<th>4th</th>
<th>5th</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1. Was the play time reasonable?</td>
<td>3.5</td>
<td>3.0</td>
<td>4.3</td>
<td>4.8</td>
<td>3.8</td>
</tr>
<tr>
<td>Q2. Was the experiment tiring? (1: I was not tired at all, 5: I was very tired)</td>
<td>2.3</td>
<td>3.0</td>
<td>3.8</td>
<td>3.8</td>
<td>3.5</td>
</tr>
<tr>
<td>Q3. Was the activity carried out appropriately?</td>
<td>3.8</td>
<td>3.8</td>
<td>4.3</td>
<td>4.0</td>
<td>4.3</td>
</tr>
<tr>
<td>Q4. Was this game enjoyable?</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
</tr>
<tr>
<td>Q5. Would you like to play this game in the future?</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
<td>4.0</td>
<td>4.3</td>
</tr>
<tr>
<td>Q6. During negotiation, was there an increase in the communication between you and your partner?</td>
<td>3.7</td>
<td>4.0</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Q7. During joint land ownership, was there an increase in the communication between you and your partner?</td>
<td>3.8</td>
<td>4.0</td>
<td>4.3</td>
<td>4.0</td>
<td>3.8</td>
</tr>
<tr>
<td>Q8. What do you think is the appropriate cost for one game? [Yen]</td>
<td>175</td>
<td>163</td>
<td>163</td>
<td>175</td>
<td>175</td>
</tr>
</tbody>
</table>

### Table 5. Usability of tablet PCs

<table>
<thead>
<tr>
<th></th>
<th>LaVie</th>
<th>TW</th>
<th>Viliv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Was the terminal easy to hold?</td>
<td>3.3</td>
<td>2.5</td>
<td>4.0</td>
</tr>
<tr>
<td>Were your eyes tired looking at a screen continuously? (1: I was very tired, 5: I was not tired at all)</td>
<td>3.8</td>
<td>3.3</td>
<td>3.5</td>
</tr>
</tbody>
</table>

4.3. Discussions

The positive responses for Q4 and Q5 (above 4.0) in Table 4 indicate that players did not get tired even when the game was played several times. Additionally, the results of Q8 show low variation. Therefore, we believe that this system will fulfill the criteria of exercise continuity and entertainment.

Based on the answers from Q6 and Q7, which remained consistent in subsequent rounds, we think that the negotiation and joint land ownership functions influenced the improvement of strategy for this system. But from the results of Q6, the negotiation was carried out only by a game of 40 minutes. So, we understood that players took time to carry out the negotiation.

The results in Table 5 (4.0/5.0) show that Viliv was generally the easiest to hold of the three tablets. This
makes sense given the size and weight of the terminal shown in Table 1. There was not a big difference regarding the eyestrain. It follows that the terminal most suitable for this system is Viliv.

“Gamification” is an informal umbrella term for the use of video game elements in non-gaming systems to improve user experience (CX) and user engagement [9]. Our system takes in marks structure of the game. So, we may call our system as a gamification system. There is another study that is going to relate exertainment to gamification [10].

5. Conclusion

We have developed a strategic exertainment system using location information named RANTORE. The RANTORE system supports outdoor exercise using position information.

The results of our experiments suggested the following:
(1) When subjects used this system, they walked an average of 1,700 m, but the exercise was not strenuous.
(2) Even if a subject used this system several times, there is no change in their desire to “try again” (4.2/5.0) and or in their opinion that the game was “enjoyable” (4.3/5.0). As a result, the entertainment characteristics and the exercise continuity are high. In addition, the negotiation and joint land ownership functions may influence strategy-related improvement.

Based on these results, it may be said that system is an effective exertainment system that encourages enjoyable exercise. In future work, we compare effect with the system and without the system, and we intend to make the system even more enjoyable.

References