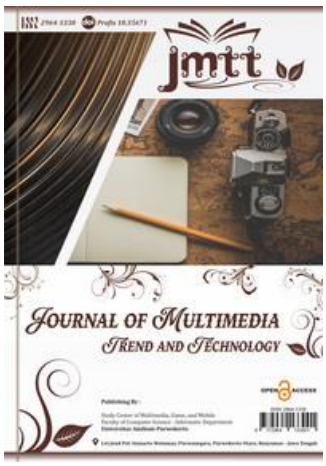
Journal of Multimedia Trend and Technology - JMTT
Vol. 3, No. 3, December 2024, ISSN 2964-1330
https://journal.educollabs.org/index.php/jmtt/

Marble Maze Game Design Using Augmented Reality Technology

Affan Mahtarami[1], Eddo Ertino[2]

[1,2]Informatics Engineering, Faculty of Industrial Technology, Islamic University of Indonesia, Yogyakarta 55501, Indonesia
email: [1]affan@uii.ac.id, [2]whoneedsshelter@gmail.com

ARTICLE INFO



History :

Submit on 10 October 2024
Review on 20 November 2024
Accepted on 25 November 2024

Keyword :

Augmented Reality;
Mixed Reality;
Game;
Marble Maze

ABSTRACT

Augmented Reality (AR) combines computer-generated graphic objects with real objects, so that virtual collaboration occurs between the two types of objects. The main purpose of AR is the use of computers as devices to facilitate a job done by humans. Based on its characteristics, AR has great potential to be used as a computer game platform. The research reported in this paper raises the issue of utilizing AR as a computer game platform. The research was conducted in the form of developing a marble maze computer game using AR with an emphasis on the interaction aspect. The lighting conditions of the playing environment have a crucial influence. To get a consistent appearance, adequate lighting is needed. However, AR-based games are one of the interesting games to play. The game must be played in well-lit environments, with a flash light, or with a high-sensitivity camera in order to get around this. Nonetheless, the majority of volunteers acknowledged that they were open to playing games that used augmented reality.

Corresponding Author:

Affan Mahtarami ✉
Informatics Engineering, Faculty of Industrial Technology, Islamic University of Indonesia Kaliurang Km. 14 Yogyakarta 55501, Indonesia. Phone. (0274)895287 ext. 122, Fax. (0274)895007 ext. 148
E-mail: affan@uii.ac.id

INTRODUCTION

Augmented Reality (AR) is a form of "mixed reality" technology, which is a technology that combines the real world with the virtual world. Augmented Reality is a variant of virtual reality (VR) [1][2]. However, AR is different from VR which completely brings users into the virtual world immersively. AR combines graphic objects generated by a computer with real objects, so that virtually there is collaboration between the two types of objects. VR can be seen as a middle ground between VR and the real world [3]. The main purpose of AR is the use of computers as devices to facilitate a job done by humans. AR has three main characteristics, namely [4]: (1) combining the real world with the virtual world, (2) interactive in real time, and (3) registered in a 3D virtual environment. The use of AR improves the user's experience and interaction with the real world.

As a relatively new technology, AR has been utilized in various fields and applications, such as: education, military, health, art, tourism, and entertainment [5]. Based on its characteristics, AR has great potential to be used as a platform for computer games. In this case, AR creates a different interaction technique and playing experience from virtual platform computer games, namely by collaborating real actions or objects with virtual environments [6].

The research reported in this paper raises the issue of utilizing AR as a computer game platform. The research was conducted in the form of developing a marble maze computer game using AR as its platform [7]. Marble maze was chosen because this game was not originally a computer game but a traditional game as seen in Figure 1. Traditional marble maze games are played using interaction techniques based on real-world physical properties [8]. In its development, marble maze games were also made in computer game format, but by eliminating interactions based on real-world physical properties and replacing them with a mouse or keyboard. Thus, this research attempts to combine real and virtual marble maze games using the AR platform [9].

There are several studies on the use of AR as a game platform. Exploration of the use of AR for a game platform using AR-Toolkit, Virtools, and 3DS Max to create a portable interactive platform that empowers the environment and markers to construct game scenarios [10]. The purpose of the study was to realize empathetic interactions between players and the characters played (avatars). The study succeeded in presenting special empathy to the audience in playing the game because the interactions used were simple hand movements, replacing interactions that were not common in a 3D virtual environment [11].

Investigations into AR-based interaction techniques for Real-Time Strategy (RTS) games have been widely conducted and discussed. In one study, an RTS game used an interaction technique called possession to support the interaction characteristics of RTS games [12][13]. From this study, it can be learned that the development of an AR-based game extension must consider the interaction characteristics of the game type. Meanwhile, several traditional games that have been developed into AR-platform games include Rubik's, Monopoly, and Checkers [14]. In general, in the three games, the interaction is carried out by the player as the traditional version of the game is played. Meanwhile, the results, or changes, produced are displayed on the computer screen (virtual) [15].

METHOD

The nature of the research conducted is game development with an emphasis on the interaction aspect [11][9]. In the game development process, the stages carried out are: (1) Design, (2) Implementation, and (3) Evaluation/Testing. These steps are the reference for the research method used. Design is the initial stage of the game development process where everything that will be created is designed first. The design results are then realized in the implementation stage. At this stage, the game is produced in the form of software and hardware that supports it, namely markers. The last stage is Evaluation/Testing. Evaluation is carried out by conducting playtesting by several prospective users. The steps taken can be seen in Figure 1 below:

Figure 1. Stages of completing the game design

At the design stage, several things are designed, including: interaction techniques, layout levels, interfaces, interface hierarchies, and markers. Interaction techniques are designed by referring to the interactions carried out in traditional marble maze games. An example of a game that will be designed is a Maze model, where players will be presented with a logic game to complete a challenge in the game area. Illustrations of the Maze game can be seen in the following 2 traditional maze forms:

Figure 2. Bentuk permainan maze secara tradisional.

In the implementation stage, everything that has been designed in the design stage is worked into a game. In the development process, several software are used, namely: Flash-Develop, Adobe Flash CS4, CorelDraw X3, Adobe Photoshop CS2, Flex SDK, and several libraries consisting of FLAR-Tool-Kit, Jiglib, and Papervision3D. While the hardware used is a set of computers with a 2.3 MHz dual core processor and 2 GB of memory, and a web cam camera.

In the evaluation stage, testing was carried out on the game that had been realized through playtesting activities. As volunteers, ten people were willing to do playtesting. The ten people were given the opportunity to play the marble maze game. Then the ten volunteers were interviewed to be asked about interface design, level design, ease of use, challenges, and AR-based interactions.

RESULT

The following is a discussion of the results we did. In accordance with the phase we used, namely using a 3-step prototype, this discussion will be reviewed in stages. The stages of the discussion are as follows:

3.1. Design.

At the design stage, several things are designed, including: interaction techniques, layout levels, interfaces, interface hierarchies, and markers. Interaction techniques are designed by referring to the interactions carried out in traditional marble maze games. In traditional marble maze games, the movements made by players when playing are to raise or lower the sides of the playing field with an axis at the center point of the board which is usually rectangular. By raising one side of the board, or lowering the opposite side, one side will automatically be higher than the other side. Thus, the marbles will move towards the lower side. This interaction technique is used by players to direct the marbles towards the exit or destination according to the winding path (maze) on the board.

In the marble maze game that was developed, the interaction technique used is the interaction technique as in the traditional marble maze game. The player holds a piece of paper with a marker image, then points it towards the webcam camera. The player then moves the paper in a rotational movement pattern to be able to move the marbles on the board. Rotation can be done in the vertical direction (x-axis and z-axis), or in the horizontal direction (y-axis). Visualization of the movements that can be done by the player is shown in Figure 3. In addition to rotational movements, players can also move the board in all directions. However, this movement does not cause the marbles to move relative to the board. Meanwhile, the movement of the marbles is a result of the slope of the plane. The direction of movement of the marbles is towards the lowest point of the plane.

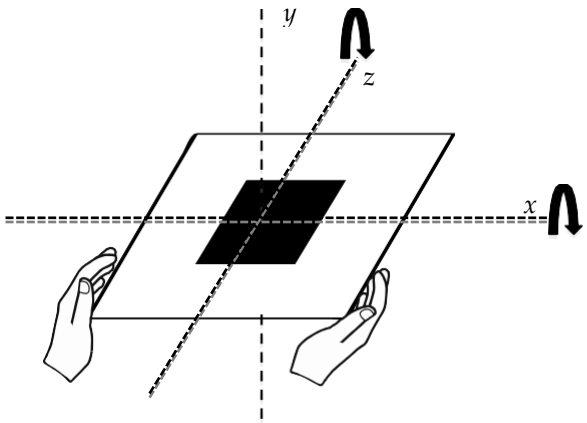


Figure 3, Design of interaction movements by players

There are four directions of movement, namely to the right (positive x-axis direction), to the left (negative x-axis direction), forward (positive z-axis direction), and backward (negative z-axis direction). While the speed of movement adjusts to the slope of the plane. The greater the angle of inclination of the plane, the greater the speed of the marbles. The marble motion design is made in the form of a Finite State Machine (FSM) which is shown in Figure 4. From the FSM, it can be seen that at the time of initiation the marble speed is 0, or the marble is at rest.

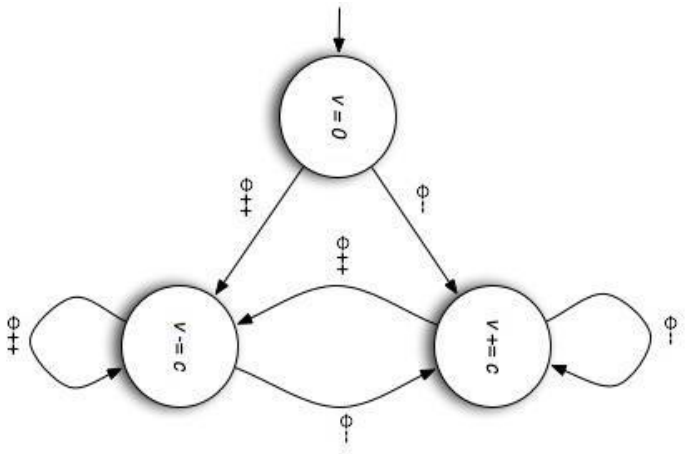


Figure 4, Marble speed FSM game model

3.3. Implementation.

Everything that was created during the design phase is turned into a game during the execution phase. FlashDevelop, Adobe Flash CS4, CorelDraw X3, Adobe Photoshop CS2, Flex SDK, and a number of libraries, including FLARToolKit, Jiglib, and Papervision3D, are among the programs utilized in the development process. A pair of PCs with a 2.3 MHz dual core processor, 2 GB of RAM, and a webcam camera make up the hardware.

One of the key components during this implementation phase is the webcam camera. The performance of this game improves with the quality of the webcam camera being used. To view how this maze game operates, the webcam should be pointed in the direction of the horizontal plane. Additionally, optimal lighting is necessary for this game. The webcam can clearly record the markers pointing at it if there is sufficient light. It is advised to use illumination aid from a flash light while using it in spaces with poor lighting. When playing, players move paper that has been marked with a marker Figure 5.

(a) (b) (c)

Figure 5, Some pages of the marble maze game interface, (a) intro page, (b) maze selection page, and (c) instruction page.

The result of the implementation stage is a marble maze game application with several interface pages, namely: intro page, maze selection page, and instruction page Figure 6. In its use, the player selects the start menu, then selects the maze to be played.

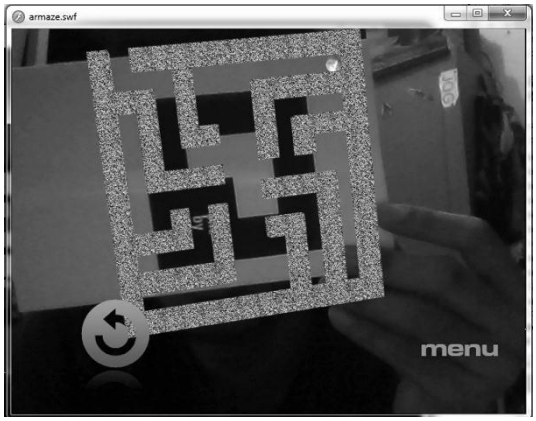


Figure 6, Game situation.

3.4. Evaluation.

In the evaluation stage, testing was carried out on the game that had been realized through playtesting activities. Ten volunteers were willing to do playtesting. The ten people were given the opportunity to play the marble maze game. Then the ten volunteers were interviewed to be asked questions related to interface design, level design, ease of use, challenges, and AR-based interactions. Of the ten volunteers, six stated that the interface design was good, three stated that it was sufficient, and one stated that it was not. Meanwhile, from the level design aspect, three volunteers stated that it was good, while the rest stated that it was still not complicated enough. For the ease of use aspect, six volunteers stated that it was easy, while the rest stated that it was difficult. And for questions related to the AR-based interactions used, seven volunteers stated that they were interested and the rest stated that they were not interested.

CONCLUTIONS

Marble maze game with AR-based interaction has been successfully realized. The interaction design based on the traditional marble maze game interaction technique makes the game familiar to players. Although in playtesting some players said it was easy, most of the volunteers said it was difficult to operate this game. This is because the use of a webcam requires sufficient lighting so that the game display on the computer screen is consistent. To overcome this, the game must be played in adequate environmental lighting conditions, or using a flash light, or using a camera with high sensitivity. However, most volunteers admitted that they were interested in playing games with AR-based interaction.

REFERENCE

[1] D. Herumurti, A. A. Yunanto, G. A. Senna, I. Kuswardayan, and S. Arifiani, “Development of first-person shooter game with survival maze based on virtual reality,” in *2020 6th Information Technology International Seminar (ITIS)*, 2020, pp. 81–86.

[2] E. Molla and V. Lepetit, “Augmented reality for board games,” in *2010 IEEE International Symposium on Mixed and Augmented Reality*, 2010, pp. 253–254.

[3] R. Wetzel, R. McCall, A.-K. Braun, and W. Broll, "Guidelines for designing augmented reality games," in *Proceedings of the 2008 Conference on Future Play: Research, Play, Share*, 2008, pp. 173–180.

[4] J. Li, E. D. der Spek, L. Feijs, F. Wang, and J. Hu, "Augmented reality games for learning: A literature review," in *Distributed, Ambient and Pervasive Interactions: 5th International Conference, DAPI 2017, Held as Part of HCI International 2017, Vancouver, BC, Canada, July 9--14, 2017, Proceedings 5*, 2017, pp. 612–626.

[5] A. J. Bushner, "Hobbyist Board Game Design Practices: How Do Board Game Designers Craft Their Rules Manuals and Solicit User Feedback on Prototype Games?," Purdue University Graduate School, 2020.

[6] H.-T. Hou, Y.-S. Fang, and J. T. Tang, "Designing an alternate reality board game with augmented reality and multi-dimensional scaffolding for promoting spatial and logical ability," *Interact. Learn. Environ.*, vol. 31, no. 7, pp. 4346–4366, 2023.

[7] T. L. Andersen, S. Kristensen, B. W. Nielsen, and K. Grønbæk, "Designing an augmented reality board game with children: the battleboard 3D experience," in *Proceedings of the 2004 conference on Interaction design and children: building a community*, 2004, pp. 137–138.

[8] Z.-T. CHENG and L. E. E. Chien-Sing, "Augmented Reality Maze Game with Google Cardboard for Child Edutainment," in *International Conference on Computers in Education*, 2020.

[9] M. Abbaszadegan, S. Yaghoubi, and I. S. MacKenzie, "TrackMaze: A comparison of head-tracking, eye-tracking, and tilt as input methods for mobile games," in *Human-Computer Interaction. Interaction Technologies: 20th International Conference, HCI International 2018, Las Vegas, NV, USA, July 15--20, 2018, Proceedings, Part III 20*, 2018, pp. 393–405.

[10] A. R. See, "ArchiCAD, 127, 141 Artificial Neural Network (ANN) software, 28 The Art of Defense board game, 210 ARToolkit, 220," *Evaluation*, vol. 284, no. 286, p. 285t.

[11] P. Sajjadi, E. O. Cebolledo Gutierrez, S. Trullemans, and O. De Troyer, "Maze commander: a collaborative asynchronous game using the oculus rift & the sifteo cubes," in *Proceedings of the first ACM SIGCHI annual symposium on Computer-human interaction in play*, 2014, pp. 227–236.

[12] B. Morschheuser, M. Riar, J. Hamari, and A. Maedche, "How games induce cooperation? A study on the relationship between game features and we-intentions in an augmented reality game," *Comput. Human Behav.*, vol. 77, pp. 169–183, 2017.

[13] N. Pellas, P. Fotaris, I. Kazanidis, and D. Wells, "Augmenting the learning experience in primary and secondary school education: A systematic review of recent trends in augmented reality game-based learning," *Virtual Real.*, vol. 23, no. 4, pp. 329–346, 2019.

[14] M. I. Rosli, S. Omar, A. N. Jaafar, R. Abdullah, N. Fadzal, and M. W. Rosli, "Implementing Arduino in the Classic Gameplay Marble Maze Labyrinth," in *2024 IEEE International Conference on Applied Electronics and Engineering (ICAEE)*, 2024, pp. 1–6.

[15] Y. Xu, E. Barba, I. Radu, M. Gandy, and B. MacIntyre, "Chores are fun: Understanding social play in board games for digital tabletop game design," in *Proceedings of DiGRA 2011 conference: think design play*, 2011.