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andar@petra.ac.id ABSTRACT Over time the kingdom of Majapahit is one of the historical heritage sites that began to disintegrate over time. That conditions because people are not interested to see the historic relic site located in East Java, Indonesia. But with the development of technology, especially virtual reality today, it is possible to visualize almost everything. In this research, we use virtual reality as an interactive and interesting information media to create environment along with atmosphere in Majapahit kingdom glory era especially in Trowulan. By using this system, we are expected could attract public interest to learn more about the history of Majapahit. The created system includes the process of making a game world such as settlement, virtual humans which is includes fishermen, farmers, adult men, adult women, children, warriors, and virtual animals like chickens, dogs, and also there is a player that can be controlled by user. The virtual humans and virtual animals will have finite state machine design to regulate the behavior and habits. This system is made using Google cardboard software development kit and Unity and will run on android devices. Keywords: virtual reality, Trowulan, finite state machine

I. INTRODUCTION Majapahit is the only major kingdom recorded in history, as a work that can unite the entire archipelago that became the pride of the Indonesian nation. However, very few know that Majapahit greatness is built through a long struggle process with blood sacrifice and based on high idealism. As the capital of Majapahit, Trowulan is one of the vast cities located in the kingdom of Majapahit. There are many relics of Majapahit in Trowulan and surrounding areas. Appeared on the surface of the land, among others, in the form of temples, gates, ponds, foundations of buildings, and other archaeological objects such as statues, yoni, inscribed stones, stone pedestals, and so forth [1]. Over time the kingdom of Majapahit is one of the historical heritage sites that began to be destroyed by time and the lack of government attention to the relics of history makes this relics of the site become unkempt and its shape cannot be seen again perfectly. This conditions will cause people are not interested to come see the historic relics site located in East Java, Indonesia. In this research, by using the existence of virtual reality technology today, we try to create the residential building back in Trowulan more perfect and the size resembles the original. To rebuild a settlement in the glorious era of the Majapahit kingdom also required the atmosphere and environment that existed at that time. To create an atmosphere in the glory of Majapahit, we used virtual humans. By using virtual humans, we can create simulation of humans that can move according to their behavior in that era. These virtual humans are applied finite state machine method, so they can move according to the command or state that has been created. Therefore, virtual reality can create an environment along with the atmosphere in the glorious era of the Majapahit kingdom to draw back the interest of the community in seeing and feeling back the history of the kingdom of Majapahit and know more closely the culture of the Majapahit kingdom. II. LITERATURE REVIEW A. Virtual Reality Virtual reality is a term used to describe an artificial reality created for a particular

purpose. The term virtual itself means something that has the essence and impact but is not a fact, it means there is no limit to whether an object can be said as a virtual object of origin is still within the scope of something unreal. Unlike virtual, reality has more complex meaning, reality has meaning as a real condition or quality, something that exists independently apart from ideas about something, and something that is the real thing that is distinguished from something that is not or less clear. Simply reality is a place, or a real object that we can feel. Based on both understanding of virtual and reality it can be concluded that virtual reality is an artificial reality that is not real but can be felt and give a real impact. [2] B. Unity Unity technologies was built in 2004. Unity was originally built as a tool that can be used by indie developers to develop games without the huge cost. The focus of Unity's founding company is to create a software that everyone can use. Besides can be obtained for free, Unity also supports the making of multiplatform games so the results of making in Unity can be used to be played on various devices. Unity also supports the making of games from various genres, ranging from 2D games to 3D games. [3] C. Game-based Learning Game is a popular media by many people, especially children, seeing this potential many game developers use games as educational media that can be given to the children as a medium of entertainment and lessons. [4] The approach used by game-based learning to create a game that can be enjoyed is to unify the content of learning materials with the game genre, basic learning incorporated into the game, effectiveness, sources, the use of games in general, design, simulation D. Game Simulation Games that circulate in the community has many genres, one of which is a simulation game. The genre of simulation is a bit different from other genres, because if other genres usually maximize the use of the fantasy world as a virtual world, and different rules of the real world to provide a totally different game experience from the real world, the simulation genre creates a virtual world that is as closely as possible to the world of origin, the rules that apply to the simulation game is also clear, that should be as similar as possible or equal to all the rules that apply to the real world. The purpose of game simulation is often not as a medium of entertainment, but rather shown for learning, art, training, and more. [5] E.

> **Finite State Machine Finite state machine consists of a set of states**   5

that determine decision making. Each state may move to another state if it satisfies predetermined conditions.

> **Finite state machine is a control system design methodology that describes the behavior or working principle of the system using the following three things: state, event and action.**   1

[6] III. SYSTEM DESIGN In this system design we will explain about game world design, system flowchart, behavior of humans and animals, and the design of system interface. A. Game World Design The game setting is a settlement located in Trowulan. This world game contains a variety of virtual humans that resemble humans and animals in ancient time. The number of people and animals in a place depends on its kind. Settlement design

> **can be seen in Figure 1. Figure 1.**   9

Game world design As the game progresses there will be day and night changes, resulting in changes in the world game such as the lights on, and the atmosphere of the sky becoming darker. This change will also affect the behavior of virtual humans that exist in the game. B. Game System Design Figure 2. Game system flowchart The system begins with a preview of the menu that consists of several options, the first option is to start the game. The second option is to display help in the simulation game used to help the user understand how to control the user's character in the game, the instructions will be displayed in the form of images. The last option is exit to end the game, and if the user selects this then the system will stop. The game system flowchart can be seen in Figure 2. C. Human and Animal Behaviors Design Behavior of humans and animals begins with status checking, starting from the status of energy, hunger, thirst. If one of the status is not fulfilled then the humans or the animals will do the filling of that status. When all the status is met, it will run a random action that starts by randomizing a number and then executing the action according to the resulting number. Once the action is completed, the process will repeat to the initial status check. The humans and animals status flowchart can be seen in Figure 3. Figure 3. Flowchart of human and animal status D. Interface Design In Figure 4 and Figure 5 can be seen interface design menu for initial view when the application starts. The menu interface design consists of three options: start, help and exit. Figure 4. Menu interface design Figure 5. Help interface design Figure 6. Interface design menu in the game Design the menu display in the game, can be seen in Figure 6 for in game mode. On the menu there are two main options are menu to return to the menu interface, and the second is the next scene to move to the next place, and the third exit is used to exit the application Figure 7 Interface design information in the game The last interface design is the interface design to display information from within the Trowulan city. In addition to conveying information visually, the information is also conveyed in audio via the speaker picture button to facilitate the user in receiving the submitted information, which can be seen in Figure 7. IV. EXPERIMENTAL RESULT A. How the System Works The system works when the game starts will show the options menu to start the game or read instructions on how to use the system. When the game starts, it will display two screens that have the same image. VR mode is possible because this system uses smartphone devices that will be placed on a VR media such as Google Cardboard. The smartphone device will capture the movement made by the user, supported by the gyro sensor. Gyro sensor is a sensor that has been implemented into many smartphone devices. The function of the gyro sensor itself is a sensor that serves to determine the orientation of motion on an object by relying on an axis. For camera shifting, this system utilizes Google Cardboard and is given two cameras each to represent the right and left eyes of the user, and to move the player in the game the user can press a button on Google Cardboard. B. Player Movement Testing In the system, the player is a parent of cardboardmain. Cardboardmain itself is an object owned by the Google VR SDK that contains functions supporting the VR technology. The first test is user-controlable. In Figure 8 can be seen a change in position when the user presses an existing button on Google Cardboard. A B C Figure 8. Player road ahead C. Testing of Humans and Animals Behavior Every human and animal has the same behavior and the different from the others based on the finite state machine of each human or animal, and the availability of animation for each human or animal. The states that are confirmed to exist in every human and animal are walk, idle, and home. In Figure 9 can be seen walk state that exist in the human, walk at random. A B C Figure 9. Walk state. (A) Male starting point, (B) Man running walk animation, (C) Man still running animated walk and move place. D. Farmers Farmers have animation to grow crops in the morning and come home at night by adding and reducing farm status. In Figure 10 (A) shows farmer farm state, starting when the farm status is less than fifty. Farmer will start from the walk state into the farm state, as in Figure 10 (B) the farmer start the farm state and add value from the variable farm. When the farm status is greater than one hundred then the farmer will return to the walk state as in Figure 10 (C). A B C Figure 10. State of farmer walk and farm. (A) Farmer runs the walk animation, (B) Farmer running farm animation, (C) Farmer back. E. Fishermen Fishermen have animations for fishing in the

morning and come home at night by adding and reducing their energy status. In Figure 11 (A) shows the walk state on the fisherman, beginning when the energy status is greater than three hundred. Fisherman will start from walk state and then enter search fishing state, as in Figure 11 (B) the fisherman start fishing state and add value from energy variable. When the energy status is smaller equal to zero then the fisherman will enter the search home state as in Figure 11 (C). A B C Figure 11. State of fisherman walk and fishing. (A) Fisherman runs walk animation, (B) Fisherman enters fishing state, (C) Fisherman re-runs walk animation. F. Women Women have a evade state that is used to avoid when a woman walks close to a man then she will walk away from the man. In Figure 12 (A) shows the woman walk state, starting when the position of the woman and man is smaller equals twenty. Then as in Figure 12 (B) the woman starts the evade state and if the distance between woman and man is greater than twenty then woman returns to walk state as shown in Figure 12 (C). A B C Figure 12. Women walk and evade state. (A) Woman running walk animation, (B) Woman entering evade state, (C) Woman re-run walk animation. G. Children Children have a chase state used to pursue an animal when the status of the action reaches zero. In Figure 13 (A) shows the walk state on the child, starting when the action status is smaller equal to zero then as in Figure 13 (B), the child begins the chase state. If the status of action is greater than one hundred or the position of the child and the animal is smaller than ten then the child returns to the walk state as in Figure 13 (C). A B C Figure 13. State of child walk and chase. (A) Child runs the walk animation, (B) Child enters the chase state, (C) Child returns to run the walk animation. H. Soldiers Soldiers have animation to keep watch in the morning and come home at night by adding and reducing energy status. In Figure 14 (A) shows the walk state on the soldier, starting when the energy status is greater than three hundred, soldier will start from a walk state entering search idle state. As in Figure 14 (B), the soldier starts the idle state and adds the value of the energy variable. When the energy status is smaller equal to zero then the soldier will enter the search home state as in Figure 14 (C). A B C Figure 14. State of soldier walk and guard. (A) The soldier runs the walk animation, (B) The soldier enters the guard state, (C) The soldier re-runs the walk animation. I. Chickens and Dogs Animals have a run state that is used to avoid when the animal walks near human then the animal will run away. In Figure 15 (A) shows the walk state on the animal. Starting when the position of the animal and human is smaller equals twenty, then as in Figure 15 (B), the animal starts a run state and if the distance from animals and humans is greater than twenty then the animal returns to the walk state as in Figure 15 (C). A B C Figure 15. State animals walk and run. (A) animal running animation walk, Figure (B) animal entering state run, Figure (C) animal re-run walk animation. J. Testing Applications on Mobile Devices Application testing is performed on three mobile devices using Google Cardboard as a medium for virtual reality devices, and the specifications

can be seen in Table 1. TABLE 1. TABLE 10

OF MOBILE DEVICES USED IN EXPERIMENT Device Name Size Resolution Chipset CPU GPU RAM Samsung A7 (2017) 5.7 inch 1080 x 1920 pixels (Full HD)

Exynos 7880 Octa Octa- core 1.9 GHz Cortex- A53 Mali- T830MP3 6

3 GB Samsung Galaxy J7 (2016) 5.5 inch 720 x 1280 pixels (Full HD) Qualcomm MSM8952 Snapdragon 617

Octa- core 1.6 GHz Cortex- A53 Adreno 405 2 **GB**

7

Samsung S4 I9505 5.0 inch 1080 X 1980 (Full HD)

Qualcomm APQ8064T Snapdragon 600 Quad- core 1.9 GHz Krait 300 Adreno 320

3

2 GB In testing system on Samsung S4 devices, the system look less smooth and often experience lag so it is very disturbing the course of the system. The second test, on the Samsung J7 (2016), the system can not run smoothly because the device does not have gyro feature so the player can not do the camera rotation. The last test, the system on the Samsung A7 (2017) gives the best results, where the application runs without lag although at the sight of many objects still look smooth. The test result view can be seen in Figure 16. Figure 16. Display Testing Menu on Samsung S4 Device. CONCLUSION Using the finite state machine method, humans and animals behavior can be visualized, so that it

can be seen in the course of the **system.** Using **virtual reality technology**

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the atmosphere in trowulan residence can be felt again and we can see historical relics from majapahit like home and gate System can only run smoothly on devices with high specifications. As for medium-specific devices can also run but there is little lag at the sight of many objects. For devices with specifications that are less qualified feels very lag when running the system.

REFERENCES [1] Indonesia. Direktorat Peninggalan Purbakala, "Mutiara Mutiara Majapahit," Trowulan : Direktorat Peninggalan Purbakala, Direktorat Jenderal Sejarah dan Purbakala, Departemen Kebudayaan dan Pariwisata, 2007. [2] Sherman, W. R., Craig, A. B., "Understanding Virtual Reality : Interface Application and Design," San Fransisco, CA : Morgan Kaufmann Publishing, 2003. [3] Roedavan, R., "Unity : Game Engine Tutorial," Bandung, Indonesia : Informatika, 2014. [4] Peirce, N., "Digital Game-based Learning for Early Childhood," Ireland,: Learnovate Centre, 2013. [5] Rollings, A. Dave, M., "Game Architecture and Design: A New Edition," Indianapolis, Indiana : New Riders Publishing, 2003 [6] Wright, David R., "Finite State Machines,". retrieved 24 October,2016 from http://www4.ncsu.edu/~drwrigh3/docs/ courses/csc216/fsm-notes.pdf