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Development Intelligent Agent in Educational Game "Pesut Adventure – Borneo Animal Match-Up" with Shuffle Random Algorithm

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Abstract— Research developing Edu-game" Pesut Adventure – Borneo Animal Educational Game" is research develop Match-Up type game. In this type game, player must find match 2 images of the Borneo animals in the same time, the player must remember the position of the image to be matched. The shuffling-random algorithm used to make images position always scrambled and player never get bored playing. AI technology (artificial intelligence) is also applied on this research. Using the Finite State Machine (FSM) model, the game agent was created in funny-animals form. It will be mentoring the children to play this game like a teacher

Keywords— Pesut Adventure, Match-Up, Edu-Game, Shuffle Random, Finite State Machine

I. INTRODUCTION

Applying educational games (edu-game) as learning media can give innovation to a new porps (Sungkaew, et al, 2022; Herder & Rau, 2022), fun atmosphere in the learning process (Yang, et al, 2021; Kalmpourtzis, 2018; Bainbridge, et al 2022; Schöbel, et al, 2021). The puzzle and sounds that appear make the learning process not boring (Shi & Shih, 2015). Therefore, research was conducted to build and develop the Edu-game "Pesut Adventure - Borneo Animal Educational Game", a game that teaches the culture of Kalimantan in the form of introducing the endemic animals of Borneo such as "Pesut" or Borneo dolphin, hornbills, deer pigs, brackish, sun bears, and others.

In developing match-up games that sharpen memory, the pair of picture puzzle objects cannot be placed in one position only. Even though the location of the image is closed, player will definitely remember where the pair of images are because they are static, this will make the game look boring (Andrea & Palupi, 2018; Loiacono, et al, 2018). Then the random shuffle randomization technique was carried out to randomize the position of the pairs of images, with the aim of making a game that was not static and boring. A shuffling technique that is like shuffling cards.

Because the game that is built is an educational game. So, in the game that will be built, the role of the companion will be replaced by the presence of a game agent. Game agents are game characters that are intelligently controlled using Finite State Machine (FSM) model (Hajji, et al, 2022; Aversa, 2022; Sindhu, et al, 2022). FSM logic will make game characters who accompany children to play can think for themselves according to the conditions of the game. Characters can respond happy, angry, or sad according to the child's playing style.

Many researches on games with the same technique have been carried out, among others, In Rachman's research. Etc. (Rachman, et al, 2010), the game made implements the Finite State Machine method into the game agent. The FSM method is used to describe facial animation expressions in commenting on the player's steps. The aim of the research is to create an intelligent agent that can determine the expressions and comments that facial animations should make and apply them to the "word" game management suite. A similar study, in which AI was used in the emotional face of game agents, was also published in the international publication (Courgeond et al, 2009).

In three research games Find Me! player must find where the cute character object "Nguk-nguk" is hiding. The arena in which these cute characters hide cannot be arranged in a regular order of levels, as this will inevitably make the game monotonous and boring. Arranging the sequence of arenas that will be faced by player in each level, must be done with a random shuffle technique, with the aim of making the game more challenging. (Andrea, 2013; Andrea, 2015; Yusnita, et al, 2015). The shuffle randomization theory was also applied to the edu-game of the same research team in the Magic

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Time game (Yusnita, et al, 2017)

Researchers have also developed Finite State Machine (FSM) on different genre games, namely the game "Jungle Adventure" (Andrea & Wijayanti, 2021), where FSM is combined with fuzzy Sugeno, to produce agent behavior that is not easily predictable in a picture ting game genre game.

Meanwhile, in this research, the games that hone players' ability to think quickly find and match the puzzle. Puzzle or picture objects in this game are randomized using a random shuffle position random algorithm so that the game is not static and boring. The game that will be built also applies the Finite State Machine, where the role of the child's companion will be replaced by the presence of a game agent. Game agents are game characters that are intelligently controlled using the Finite State Machine (FSM) thinking logic model.

The purpose of this research is to make a picture-matching game (math-up game) that elevates the culture of Kalimantan, to apply a random shuffle in a random position to randomize the position of the object of the picture puzzle. Implementing Finite State Machine (FSM) logic in the form of a framework model that will be applied in the game character agent.

II. Research Methods

A. Research Stage

The research was carried out through the stages of multimedia development (Tyagi, et al, 2022; Hocking, 2022; Lanham, 2017) as follows:

1. Concepting gameplay and how to apply the algorithms used, as well as collecting game-making materials.
2. The edu-game development process uses a multimedia system development method, starting from the design to the assembly stage, implementing random shuffle and FSM into the game system.
3. Installation of the edu-game application into the smartphones of children and kindergarten teachers.
4. Distribution and testing in order to produce a satisfactory percentage value.

B. Object Position Shuffle Method

To apply the randomization of the image position with the random shuffle system, the following steps are carried out:

1. Specify the number of image pairs

The beginning of the application is to determine the number of picture-pair puzzles and arrange them like a matrix as shown in Picture. 1

Picture. 1 Matrix 6 × 1 Unscrambled Number Match-Up Game

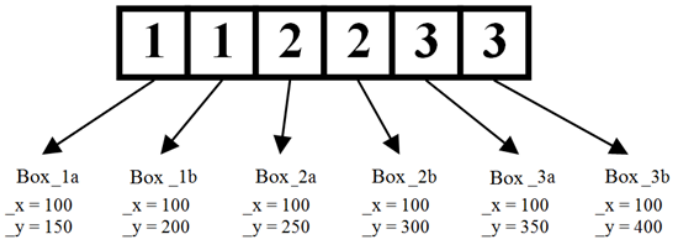
At this stage, the array value declaration is carried out as in the example script below:

```
A = new Array(1,1,2,2,3,3)
```

Where the index value of the first array (0th index) is 0, and the last index is 5.

2. Saves every x and y coordinate of every picture puzzle

Each image object or shape in the game project board must have x and y coordinates as shown in Picture 2.



Picture. 2 The x and y coordinates of the 6 picture boxes

At this stage the six coordinates of the drawing box are recorded in a procedure

```
Procedure box_position()
  if (position = 0) then
    x ←100
    y ←150
  Else if (position = 1) then
    x ←100
    y ←200
  Else if (position = 2) then
    x ←100
    y ←250
  Else if (position = 3) then
    x ←100
    y ←300
  Else if (position = 4) then
    x ←100
    y ←350
  Else
    x ←100
    y ←400
  End If
End Procedure
```

3. Position randomization coding

The last stage is the use of the random shuffle function, as well as randomizing the coordinate position of each image puzzle box according to the following randomization script:

```
position ←random.shuffle(A)
```

so that the matrix arrangement can be randomized as shown in Picture. 3.

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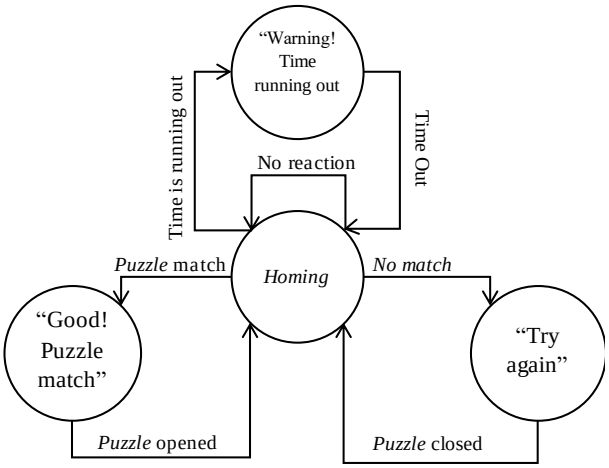
Picture. 3 Matrix 6 × 1 Randomized Number Match-Up Game

C. Design of Finite State Machine model

Finite State Machine (FSM) or also referred to as Finite State Automata, is widely used as a technique for modeling event-based phenomena or conditions (Aversa, 2022; Thampi, 2022; Sirakoulis & Adamatzky, 2015; Singh, et al, 2021). The FSM design is based on events that occur in the child's activity log while playing. The timing and number of matched picture puzzles is a priority in the FSM state framework. The behavior of the "Pesut" (Borneo dolphin) character agent is designed with a different framework for each learning and game menu, this is done to make the agent can act as the best possible companion. The following in Picture. 4 are the states on the Finite State Machine that are applied to the animal character agent:



Picture.4. FSM logic model on animal character agent

The model above explains that at the beginning of the game, the animal characters (agents) in homing mode (it doesn't do anything. The character will move to respond to the child's playing style when matching the match-up puzzle images. When the 2 puzzle pictures that are open match, the animal character will give a happy response, otherwise when the 2 puzzle pictures don't match, the animal character will give a sad response and keep encouraging them to find another picture. The last condition is when time is running out, the animal character will give a panic response and give a reminder that time is running out.

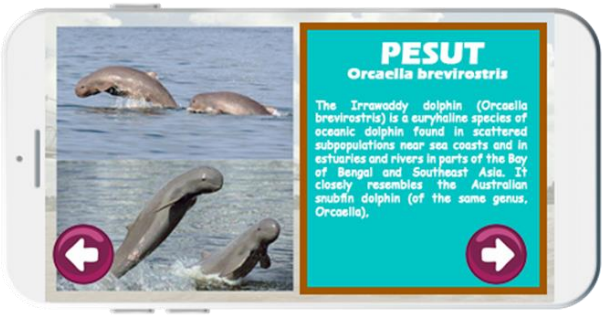
IV. Results And Discussion

*"Pesut Adventure – Borneo Animal Educational Game"*is a game Match-Up Education which is included in the category of puzzle games that can invite player to play while learning in a relaxed manner, easy to learn or play by the player. The concept of this game has simple rules and features content designed for its users for all ages especially children. This game has four menu options in the opening scene, namely learning, playing, about and also the exit menu,

*Edu-game*This game has rules, namely player must match images of the same object from the play menu, there is time at each level of the game that can train speed in remembering the same object to be matched and there is also a score or value in each level of the game that has been played by the player. This concept is assembled in the interface of Picture. 5.

Picture 5. "Pesut Adventure" opening scene interface

In the learning menu, player will learn how to play this game, and can also learn about the information on endemic animals of Borneo in real photos or in the form of funny characters. (See Picture. 6)



Picture. 6. Learning scene interface

To start the game, the player must press the play button. each game level has a different time limit and difficulty: level 1 player is required to complete 45 seconds of matching object images consisting of 6 puzzle boxes (see Picture. 7); level 2 player is required to complete 50 seconds of matching object images consisting of 12 squares; Level 3 playe is required to complete 60 seconds of matching object images consisting of 18 puzzle boxes. If the player runs out of time before completing the game, the player can choose to repeat or return to the main menu.

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Picture 7. Level 1 play scene interface

A. Design of Finite State Machine model

So that player cannot memorize the positions of the closed picture puzzle pairs in the "Pesut Adventure" match-up level, the technique of randomizing the position of the picture boxes must be carried out at every start of the game level. This means that all image positions will always change even if player play this game repeatedly.

Picture. 8. Randomize the position of the crocodile character in the Match-up puzzle

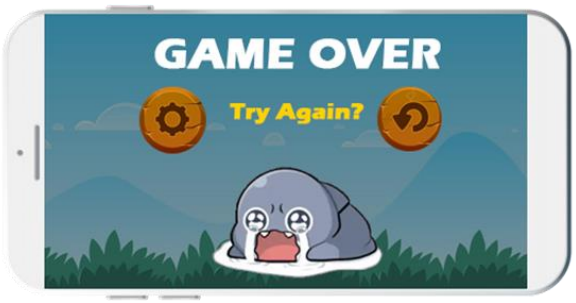
As in Picture. 8, the location of pairs of dolphin images (circle marks) can move randomly in the 3 × 3 matrix. Where the probability of guessing the position of the same 2 pictures among the 9 closed boxes is 2÷9 × 100% = 20%. The more picture box puzzles, the smaller the chance of guessing the position of the picture pairs. With the randomization of positions, player must guess where the position of the same pair of pictures is, and player cannot memorize where the position of the pair of pictures is every time they start the game, so the game is not boring.

B. Assembly Finite State Machine

The FSM logic model (Picture. 4) is applied as a pattern for the expression of funny characters in the game, funny characters will give notifications if the player is wrong or right in matching the puzzle, and give notifications when time is running out.

Picture. 9. Notifications in the form of character "Pesut" with expressions

It can be seen in Picture. 9, animal characters can give sad, happy, or panic expressions when time is running out. FSM logic will make this notification appear according to the player's action. Cute animal characters can also talk and give notification sounds like a play teacher. Characters can also cry if the player loses this game. (See Picture. 10)



Picture 10. Lost scene interface (game over)

All these expressions are created with the aim of making the game interface more interactive with child. So that children who play this edu-game feel accompanied by the presence of a game agent.

C. Beta Testing

Beta testing is a live test of an application in an environment that cannot be controlled by the developer (Sindhu, et al, 2022; Hocking, 2022; Schultz, & Bryant, 2016). The trial was conducted in the form of a simple questionnaire which was filled out by teachers and kindergarten students. In this study, trials were conducted on 2 teachers and 8 students, where 2 questions were presented which refer to the gameplay and the role of the game agent. Questionnaire questions are made as simple as possible so that young children can also fill them out.

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Table 1. Result of Beta Testing

Question	Respondent's Questions			Total respondents
	good	Satisfactory	Poor	
How is this educational game?	6	4	0	10
How is the characters Games?	7	1	2	10
Total Answer	13	5	2	**20**

From the results of beta testing in table 1, it can be determined that the weight of the calculation for the "poor" answer has a weight of 1, for the " satisfactory " answer with a weight of 2, and the "good" answer with a weight of 3. Then the calculation of the average percentage of respondents' scores can be calculate:

$$\bar{X} = \frac{13 \times 3 + 5 \times 2 + 2 \times 1}{20 \times 3} \times 100 = 85\%$$

Based on the percentage obtained, the percentage is 85%, so the "Pesut Adventure - Borneo Animal Educational Game" edu-game can be accepted because the percentage value obtained is above the minimum percentage value of 50% (average), and close to 100% (very good).

V. CONCLUSION

The edu-game "Pesut" has been built, an educational game that teaches endemic animals of Kalimantan in the form of match-up games. Application development is carried out according to the multimedia development stage, starting from conceptualizing gameplay to distributing applications. The technique of randomizing the position of objects in the match-up game "Pesut Adventure" is carried out with the aim of preventing player from memorizing the positions of the object pairs of images in each level of the game, so that the game is not static and not boring. Presenting a game agent as a companion character for children to play. The Finite State Machine applied to the game agent allows cute characters in the game to interact according to the action-reaction logic of the player's playing style. This is what makes educational games more interactive for children.

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