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Application of artificial intelligence in Indonesian debate education game

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ABSTRACT

Over time, educational games that exist is increasing. It is very unfortunate that there are some educational games that are too focused on the educational aspect so that they forget their identity as games that aim to relieve fatigue. This research was conducted to avoid this problem. To provide an interesting experience from the game being played, the artificial intelligence system is implemented, the first one is Bezier Curve Algorithm. An algorithm that forms a curve trajectory that will become a cross motion of obstacles. Finite State Machine for the Non-Player Character (NPC) behavior. The last one is Fuzzy Mamdani algorithm, it is an algorithm that will be used in calculating the score in the game. By applying all the algorithm to some aspects of the game, there will be an interesting experience in every game play, because one gameplay will not be similar to the previous one. This game was developed on the Android platform. The test was conducted on 33 high school/vocational high school students with the age range (15-20 years). The results obtained, 97% of respondents agree that the game is interesting for them and 90.9% feel interested in Indonesian debate after playing the game.

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1. INTRODUCTION

Education is a learning process that aims to educate and develop the potential of each individual, this can be done in institutions both formally and non-formally. Many methods can be implemented in providing education to students, one of which is by using games. One of the educational methods that is suitable to be applied is learning while playing, thus knowledge can be more easily absorbed [1]. Providing education through games will provide an interesting experience for individuals who get it. Video game is an activity that utilizes a digital video screen to create a system of rules in which players play against other players, or play alone, this is usually done to achieve certain targets [2]. The goal of playing a game itself is to make the player release their fatigue, have fun, and relieve boredom their boredom. To enhance the interesting experience of a game, artificial intelligence systems can be added. The addition of artificial intelligence in an educational game for students will certainly improve the performance of game media as a means of education for students.

It is predicted that in 2045 the population will reach 318.96 million and the state of Indonesia will receive a demographic bonus with a productive population reaching 65.2% in the age range of 15 to 64 years [3]. With the rapid population growth in the future, of course education for them will be very important to improve their quality of life. The large number of populations will demand a more attractive, effective and

efficient educational method. Coupled with the fact that students in their productive age have a habit of playing games which causes them to have their own Gaming Profile. This Gaming Profile is very influential on growth because it is closely related to the personality of the student or student [4]. The use of artificial intelligence in educational games is one solution to this problem. Artificial intelligence can improve the quality of educational games, this is due to an artificial intelligence system that allows games to provide a more interesting experience in each game, eliminate boredom in playing the game and learn new things while playing the game.

Increasing interest in playing games can be done by adding an artificial intelligence system. Good design of artificially intelligent systems in the game would raise the game quality [5]. One of most common use models for artificial intelligence in game is Finite State Machine since the model doesn't require any training. The previous study which was done by Smolyakov Ivan Y. and Belyaev Sergey A., "Design of the Software Architecture for Starcraft Video Game on the Basis of Finite State Machines" conclude that FSM can be used in developing intelligent agents for strategic games [6]. They are also easy to implement and allowing minor hardware requirements for the debugging solutions. This approach allowing the developer to create game routine prototype faster and it is very suitable for creating the Non-Player Character (NPC) behavior.

In order to make the game more interesting, it need to have an obstacle challenge. The challenge would come in the form of a button that keeps moving on a randomized set of paths and the player needs to catch the button in order to get more score. The approach to solving this problem required an algorithm that was not too complex to generate the set of paths for the obstacle. The Bézier Curve is a simple curve parameter equation commonly used in computing graphics, animation, and various similar fields. The modern world uses the Bézier Curve in the design process of railroads, highways, networks, animation, computer graphic design, robotics, communications, and so on [7]. However, the use of a simple Bézier Curve is still limited by the fixed shape formed by the points of their polygons. This approach is suitable for generating the obstacle path in the game since the algorithm is commonly used for developing paths and does not require a complex technique.

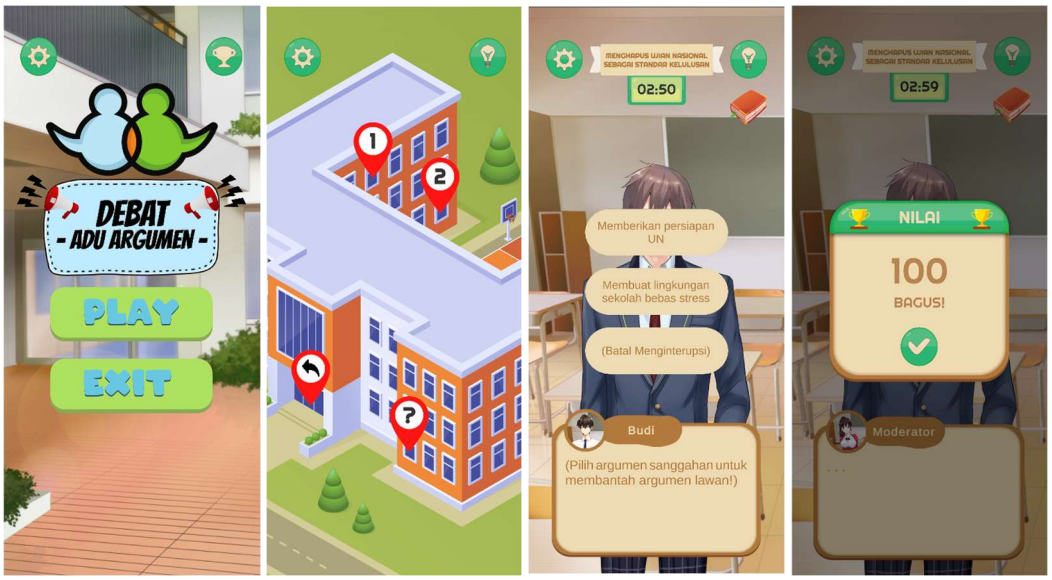
Finally, the game needs its own scoring system. The execution time of the scoring system needs to be fast, and it needs to costume less memory usage so that the memory could be altered for another use in the game and make the game run smoother. The approach to solving this problem is by using the Fuzzy Mamdani algorithm implemented in the system. This algorithm has quite a fast execution time and uses less memory usage [8]. It also can be used for grading based on some input points. This algorithm would be later used to grade the score of the player.

The artificial intelligence system will be implemented in three aspects of the game, the first one is the game obstacle which would use the Bézier Curve algorithm for creating the obstacle path, the next one is Finite State Machine that would create the Non-Player Character (NPC) behavior, and the last algorithm is Fuzzy Mamdani that would be use in the scoring system. The game will be developed on an Android-based mobile platform because this platform is a more popular platform compared to Console and PC [9].

2. MATERIAL AND METHOD

2.1. User Interface Design

The game interface and flow need to be friendly to its user, as for the design approach used for the application interface is user-centered design (UCD). This approach allowed the interface design to be user oriented and meet the satisfaction of the user's need [10]. The design starts with researching context-of-use, such as user characteristics, tasks, and physical environments to define the best design for the game interface. After conducting the research and meeting the user requirement, the final design is as follow. At the start of the game, the user will enter the main menu where there is an option to start or exit the game. There is also a setting button, where the player will be able to tweak the setting of the game, such as the sound effect and an option to pause the game. When the start menu is pressed, the game would continue to the level selection scene where the player able to choose what level they want to play. When the level is selected, the game then continues to the main game section where the debate is begun. After the debate is end, the score would be displayed, and the game would return player back to the level selection menu. The detail of the game interface is shown in Figure 1.



(a) (b) (c) (d)

Figure 1. (a) Main menu interface, (b) level selection interface, (c) main game interface, (d) scoring interface

In this session, players can select the Play button to play, the settings button to change the settings in the game and the exit button to exit the game. There is also a High Score button to see the highest score ever achieved during game play.

2.2. Game Design

The game is design to have two level and one tutorial level. In the tutorial level, the player would be taught on the most effective way to play the game so that the player could have chance to gain the maximum point in the single playthrough. The gameplay is deign based on the real-life Indonesian debate rule that has been apply nationally in the Indonesian language debate competition. Indonesian Debate is an exchange of opinions using Indonesian language. The debate is held to build awareness and concern for the importance of tolerance, cooperation, and differences of opinion as attitudes that must grow in a healthy democracy, the debate also aims to broaden general knowledge/knowledge so that they are more confident in socializing and communicating [11]. Debates have various rules, but the rules that are most often used for Indonesian language debates are those of the Asian parliament.

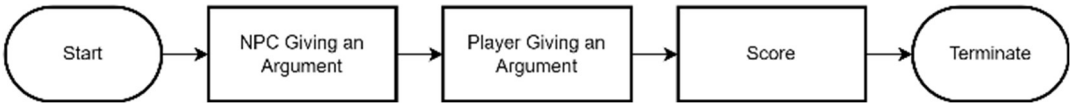


Figure 2. Game Flow

Asian parliamentary rules are similar to those of Australian parliaments, the difference lies in the ability to interrupt. The Asian rules are in the format of two teams consisting of three people each in one debate, one team will represent the Government/Affirmation (Pro) and the other team will represent the Opposition (Cons) [11]. The debate will be opened by a moderator who will then give the government team time to present their arguments first, after that, the opposing party will reply to the opponent's argument before presenting his argument as the counter party. This will be repeated until all members of the government and opposition teams have had a chance to present their arguments.

Assessment in the Indonesian language debate is carried out by a jury, a jury must meet several criteria such as having judging accreditation at national or international level, having experience as a debater or jury in national or international competitions, understanding the selection system used and determined by the National Achievement Center, Ministry of Education , Culture, Research and Technology, actively play a role and foster in the field of debate, both at the district/city, provincial, national, international and debate community levels [11]. The jury will then determine the points of each debate member using the components of style, content, and strategy [11]. The team with the highest score is the team that will win the debate

Based on that rule, the game flow is shown in Figure 2. The game system flowchart can be described as follows:

1. The game start with the enemy NPC giving its argument on the topic of the debate. In this proses at certain time, the player is able to interrupt the NPC argument and find the inconsistencies in its argument. If the player managed to interrupt the NPC argument with the correct counter argument, the player will receive and additional score.
2. After the NPC is done with its argument, it's the player turn to give their argument on the topic. The player is giving a choice to choose which argument that the player will use to gain score. At the certain time, the enemy NPC will have the abilities to interrupt the player argument, when this happened, the player is able to defend their argument. If the player chose the correct argument to defend their argument, the player will gain an additional score point for their final score.

If the player is finished with their argument. The next is accumulating all the player score. The score would be count and then displayed to the player to measure their performance on that level.

2.3. Bézier Curve

The Bézier Curve is a curve parameter equation commonly used in computing graphics, animation, and various similar fields. The modern world uses the Bézier Curve in the design process of railroads, highways, networks, animation, computer graphic design, robotics, communications and so on. However, the use of a simple Bézier Curve is still limited by its fixed shape formed from the points of their polygons [7].

The Bézier Curve is formed from several control points. When control points are assigned using the Bernstein Polynomial equation and the De Castaljeu algorithm, the Bézier Curve equation can be formed [12]. Bernstein polynomials have independent linear properties, so Bernstein polynomials give the base set for all polynomials. Using the de Casteljau algorithm and Bernstein polynomial, a Bézier Curve equation can be written as:

$$BZ(t) = \sum_{i=0}^{n} \binom{n}{i} t^i (1-t)^{n-i} P_i \, , 0 \leq \ t \leq 1 \qquad (1)$$

t = curve points
n = control points
Pi = the Bezier points.

The process of calculating the Bézier Curves algorithm in the game system will be applied to the interrupt button that will appear at a certain time when the NPC is delivering its argument. This algorithm is used to form the path to be traversed by the interrupt button. The details of this algorithm design can be seen as follows:

1. Input the initial four nodes which will be the input nodes for the algorithm calculation.
2. The path will be calculated based on formula (1) with four input nodes acting as input points, the starting node will be the starting point of the path and the end node will be the stopping point of the path.
3. After the calculation is done, among the four input nodes, a path will be formed. This path will then be passed by the interrupt button which switches from the start path to the end path every second.
4. Doing the same thing four times will create four paths that can be used by the interrupt button. Paths A, B, C, and D.
5. The interrupt button will pass through path A as the starting path, and path D as the end path. If the interrupt button has passed all the existing paths, then the button will repeat the journey process by passing through path A again as the starting path and ending in path D.
6. When it's time the interrupt button appears. A button that is initially hidden will stop in its path and reveal itself within a certain time. If the player successfully presses the button, the option to provide an interrupt argument will appear. If the player cannot press the button quickly, the button will disappear and continue on the path he is currently on.
7. Players who successfully press the interrupt button will make the back button disappear after the argument selection appears before the player. The button will then use the new path. The new paths used are paths A, B, C, and D whose positions have changed from their initial positions. That makes the trajectory to be traversed is different from the previous trajectory. This will cause

a random effect for the player, so that every time he plays and manages to press the button, the interrupt button will appear in a different place.

8. This will continue until the debate session changes to the next session.

2.4. Finite State Machine

Finite State Machine (FSM) is a decision-making process consisting of a series of states. If the pre-defined conditions are met, then each state can move to another state [13].

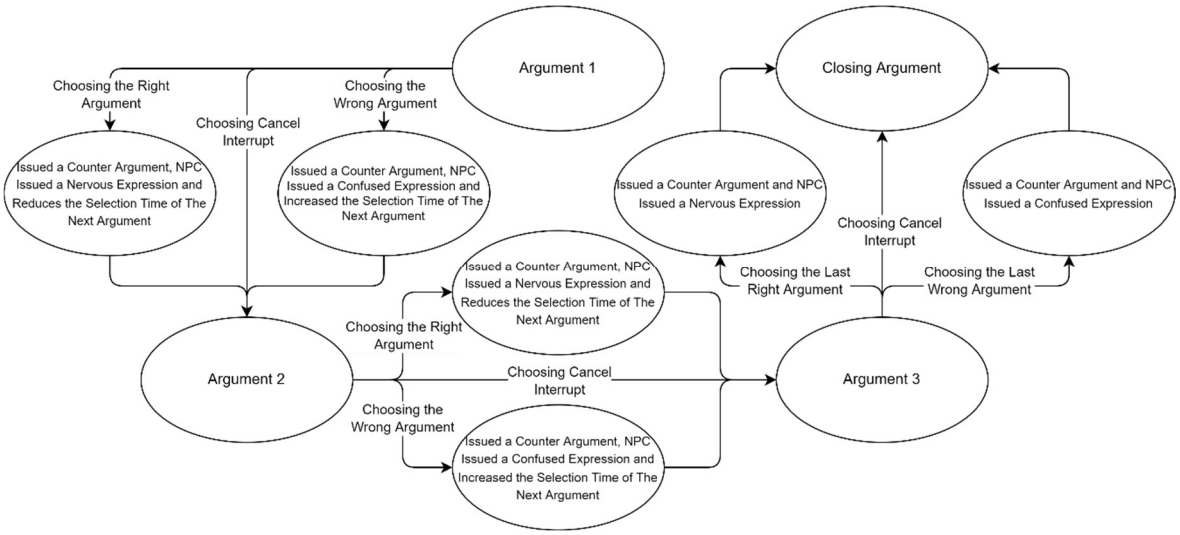


Figure 3. Finite State Machine Diagram

Figure 3 represents the state of the NPC in the game. This state starts with Argument 1 which is the initial state and ends with a Closing Argument which is the final state. The following is a further discussion of the Finite State Machine diagram above:

1. The initial condition in this diagram is the submission of arguments from the NPC. There will be three arguments by the NPC in which the player can interrupt at a certain time when the NPC is delivering his argument.
2. When the player chooses to interrupt, the NPC will behave according to the player's accuracy in choosing a counter argument.
3. In addition to being able to choose a reply to argument, players can also choose not to interrupt the argument submitted by the NPC.
4. After all the debate sessions are over, the NPC will present their closing arguments.

2.5. Fuzzy Mamdani

The Fuzzy Mamdani method is one part of the Fuzzy Inference System which functions to draw the best conclusions in uncertain problems. The Fuzzy Mamdani method in the calculation process uses linguistic rules and can be analyzed mathematically, so it can be easily understood [14]. The decision-making process can be carried out through several stages, namely defining the system inputs and outputs; fuzzification stage; inference stage; and the defuzzification stage.

At the stage of defining the input and output of this system to identify the input that will be fuzzified into a fuzzy set and become a fuzzy membership function. And identify the output of the input output to be selected.

In the fuzzification stage, the input variables will be used to find the linguistic value of each input variable. After the linguistic value is obtained for each variable, then create a membership function for each linguistic value [15]. The membership function is a form of curve or graph that can show the mapping of data input points into the membership value or the degree of membership which has an interval between 0 to 1 [16]. The degree of membership for a variable x can be denoted by the symbol (x). One way that can be used to describe the degree of membership is through the membership function approach [17].

At the inference stage, inference is a reasoning process that uses fuzzy input and fuzzy rules that have been decided to get fuzzy output results [17]. The objective obtained in this section is to obtain the fuzzy output value which will then be input to the defuzzification stage. The fuzzy output values include linguistic values and membership degrees. The steps taken at this stage, such as:

1. State what linguistic values will be used for each output variable.
2. Specifies a membership function for each linguistic value in the output variable.
3. Create fuzzy rules or rules based on linguistic values on input and output.
4. Determining the value of the fuzzy output based on the value of the fuzzy input is done using the MIN – MAX method. The MIN - MAX method uses two operations, namely the AND operation and the OR operation. AND operations and OR operations have the following equation

$$\mu_{A\cap B}[x] = \min(\mu_A[x], \mu_B[x]) \quad (2)$$

$$\mu_{A\cup B}(x) = \max\big(\mu_A(x), \mu_B(x)\big) \quad (3)$$

In the defuzzification stage, the goal obtained at this stage is to get a crisp output value as the final result. The steps taken at this stage, is to perform the process of aggregation or composition of the results obtained from the inference section. After that is performing the calculation of the crisp value using the Centroid Method with the equation.

$$y^* = \frac{\Sigma y \mu_R(y)}{\Sigma \mu_R(y)} \quad (4)$$

The process of calculating the Fuzzy Mamdani algorithm in the game system will be applied to the debate game score system. This algorithm is used to calculate the final score of the debate assessment that will appear after the argument has ended. Details of the design of the Fuzzy Mamdani algorithm can be seen as follows:

1. Define input and output variables in the debate game score system. The input variables used in this system are content input, delivery input, and strategy input. The output variable used in this system is the debate assessment output.
2. Enter values for each input variable and perform the fuzzification calculation process.
3. In the fuzzification process, each input variable will map the contents of the linguistic value and each linguistic value will map its respective membership function. Then the calculations are carried out in it.
4. After the calculation is done, the output of membership degrees is obtained for each linguistic value that exists to carry out the inference calculation process.

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4. After the calculation is done, the output of membership degrees is obtained for each linguistic value that exists to carry out the inference calculation process.
5. In the inference process, the membership degree value for each linguistic value that has been obtained will determine the rules and will get the minimum value. The minimum value is obtained by using the formula (2). Then the calculation is carried out using the formula (3) to get the maximum value from the rules and the minimum value that has been obtained. At this stage, each output variable will map the contents of its linguistic value and each linguistic value will map its membership function.
6. after the calculation is done, the maximum value is obtained to process the Clipping method and the Mamdani defuzzification calculation.

7. In the defuzzification process, the maximum value that has been obtained will be calculated using the formula (4) using a predetermined sample point in accordance with the Clipping method that has been made. So that the results of the defuzzification output are obtained and these results are converted into a scale of 1 to 100 to be used as a score for the assessment results in the debate game.
8. The process of calculating this score system will continue to be carried out after the status of the debate session ends.

3. RESULT AND DISCUSSION

3.1. Obstacle Path

Testing the Bézier Curves Algorithm is a function test related to the use of the Bézier Curves algorithm in forming trajectories in the debate game. The results of the implementation and testing of the Bézier Curves algorithm can be seen in the image below:

Figure 4. Obstacle track

In Figure 4 is the initialization of the path that has been formed from four Bézier Curves paths with each path having four control points. The gray line is the path the interrupt button will take. This trajectory will change position randomly when the interrupt button is pressed successfully. To see the test results in detail can be seen in Table 1.

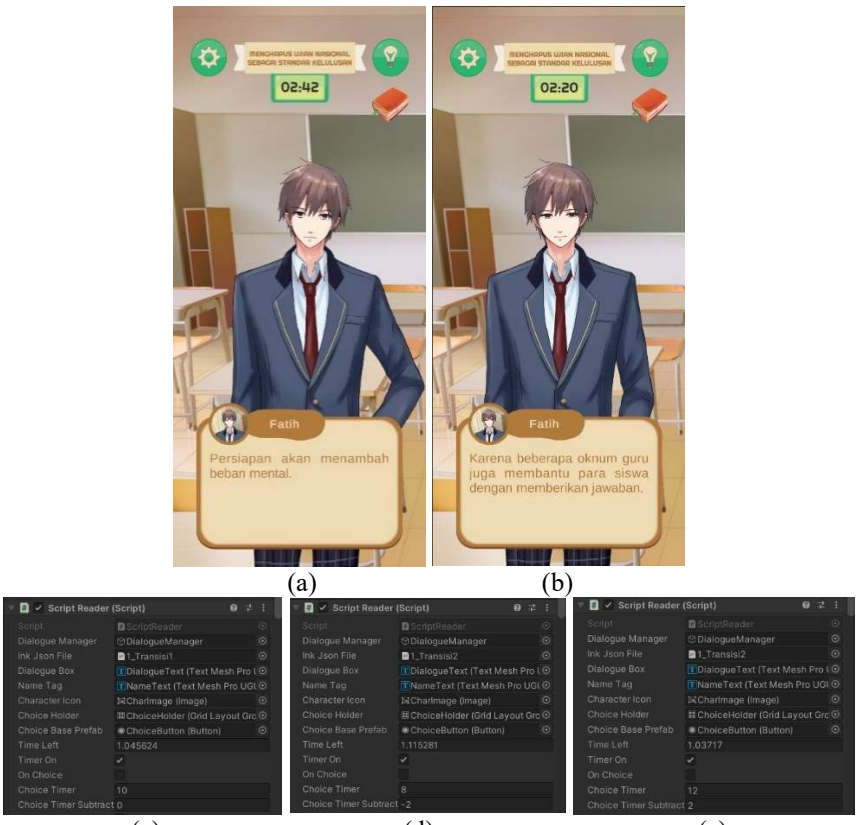
Table 1. Obstacle Test

No.	Function	Input	Output
1	Bézier Curves algorithm design on interrupt button	Four control points on each track	The trajectory is formed from the four existing control points
2	Implementation of the Bézier Curves algorithm on the interrupt button	The initial position of the interrupt button will be at the first control point of the path A	The interrupt button will move to follow all existing paths from the first control point of path A as the starting point and the last control point of path D as the end point of the path. Then the button will repeat its journey process.

Based on the test results in Table 1, the Bézier Curves algorithm applied to the interrupt button has been running well. The path will always be formed from the four existing control points, this path moves randomly every time the interrupt button is pressed.

3.2. NPC Behavior

Finite State Machine testing is a function test related to the implementation of Finite State Machine on the behavior of NPCs in setting their expressions during the debate. This test is also carried out to set the argument selection time based on the player's accuracy in choosing the argument. The results of the implementation and testing of the Finite State Machine can be seen in Figure 5.



(a) (b) (c) (d) (e)

Figure 5. (a) Nervous animation, (b) confused animation, (c) normal choice time, (d) reduce choice time, (e) add choice time

The image is the result of testing the nervous animation state on the NPC where the NPC will show an anxious facial expression when the player chooses the right counter argument. The image on the right is the test result of the confused animation state on the NPC where the NPC will show a confused facial expression when the player chooses an incorrect reply to argument.

This image is the result of testing the initial state at choice time where the argument selection time is still normal as much as ten seconds when the player has not chosen a reply argument, the choice time which is reduced by two seconds if the player chooses the right reply argument, and test result of the choice time which is increased by two seconds if the player chooses an incorrect reply argument.

The detailed results of the Finite State Machine test is shown on the Table 2 below:

Table 2. NPC Behavior Test

No.	Requirement	Condition	Action	Expected Outcome
1	idle	the debate starts or the player chooses to cancel interrupt	normal expression	appropriate
2	player selected an argument	choose the right argument	restless expression and reduced choice time	appropriate
3	player selected an argument	choose the wrong argument	confused expression and increased choice time	appropriate

Based on the test results in Table 2, the Finite State Machine applied to NPC behavior has been running well. The expression and time for the next argument selection will change according to the player's accuracy in selecting the argument.

3.3. Scoring System

Testing the Fuzzy Mamdani algorithm is a function test related to the use of the Fuzzy Mamdani algorithm in the score system in the debate game. This test is a test that aims to determine the final result of the calculation of the Fuzzy Mamdani algorithm. Based on the 60 cases that have been calculated manually,

the output in the form of defuzzification and the conditions of the debate assessment comes out. So that it can be compared with calculations through running programs to find out whether the results of the calculations are the same or not, which can be seen below:

Table 3. Scoring System Test

Case	Data Value			
	Manual Fuzzy Mamdani Calculation	Manual Index Calculation	Game Fuzzy Mamdani Calculation	Game Index Calculation
1-15	29.925	KB	29.925	KB
16-20	87.4	B	87.39998	B
21-30	68.225	CB	68.22502	CB
31-60	87.4	B	87.39998	B

The index KB stands for Improvement Needed, CB for Good, and B is for Exceptional. Based on the test results in Table 3, Fuzzy Mamdani applied to the scoring system work well to calculate the game index. Calculation was performed on 60 different cases, where the cases represent a variety of score point input to determine the index calculation. The result show that calculations in cases 1 to 60 which are calculated manually get the same value and index results as those calculated in the game scoring system.

3.4. User Testing

The test aims to determine the user satisfaction and acceptance of the game. The approach used for this testing is the User Acceptance Test (UAT). UAT goal is to find out whether or not a software satisfies users acceptance criteria [18]. The test was carried out on 33 high school / vocational students equivalent to the criteria of youth with an age range between 15 and 24 years old. In this test, the user will act as a game player to try the debate game. After the user has finished playing this game, the user will be asked to assess the suitability of the system with the design that has been made and whether the system is running well or not. The result of the test is shown in the table below:

Table 4. User Experience Test

No	Question	Response		
		Disagree	*Neutral*	*Agree*
1	this debate game is quite interesting for you	0%	3%	97%
2	this game makes you interested in indonesian debate	0%	9.1%	90.9%
3	the game obstacle is working well	3%	15.1%	81.9%
4	the enemy's behavior in the game is working well	0%	9.1%	90.9%
5	the game scoring system is working well	0%	15.1%	84.9%

Based on the test result, it could safely be said that the game is meeting the acceptance criteria of the users and that all of its features are working well. The game is quite interesting for the users, and it makes them have more interest in Indonesian Debate after playing the game. All the implemented artificial intelligence is running as they should be since the user finds them working well in the game.

4. CONCLUSION

The results of testing the Bézier Curves algorithm function well to create a path for the interrupt button, the Finite State Machine method applied to the NPC is successful in creating NPC routines, and the Fuzzy Mamdani algorithm applied to the debate game score system work well in making the final scoring system in the game. Based on the 33 respondents, 97% of respondents agree that games are interesting to them and 90.9% feel interested in Indonesian debate after playing the game. So, it can be said that this game increases students' interest in Indonesian language debate material and at the same time having an interest in the game itself.

REFERENCES

[1] V. W. Febriani, B. Chandrawati, and D. Widiantoro, “Making Education Game to Choose Healthy Snacks for Children,” *SISFORMA*, vol. 3, no. 1, p. 26, Feb. 2017, doi: 10.24167/sisforma.v3i1.621.

[2] B. Purkiss and I. Khaliq, "A Study of Interaction in Idle Games & Perceptions on the Definition of a Game," in *2015 IEEE Games Entertainment Media Conference (GEM)*, Oct. 2015, pp. 56–61. doi: 10.1109/GEM.2015.7377233.

[3] D. Arodha, "Optimizing Waqf Management for Demographic Bonus in Indonesia," *Journal of Islamic Economics Perspectives*, vol. 3, no. 2, pp. 39–46, 2021.

[4] B. Manero, J. Torrente, C. Fernandez-Vara, and B. Fernandez-Manjon, "Investigating the Impact of Gaming Habits, Gender, and Age on the Effectiveness of an Educational Video Game: An Exploratory Study," *IEEE Transactions on Learning Technologies*, vol. 10, no. 2, pp. 236–246, Apr. 2017, doi: 10.1109/TLT.2016.2572702.

[5] C. Tang, Z. Wang, X. Sima, and L. Zhang, "Research on Artificial Intelligence Algorithm and its Application in Games," in *Proceedings - 2020 2nd International Conference on Artificial Intelligence and Advanced Manufacture, AIAM 2020*, Oct. 2020, pp. 386–389. doi: 10.1109/AIAM50918.2020.00085.

[6] S. Ivan Y. and B. Sergey A., "Design of the Software Architecture for Starcraft Video Game on the Basis of Finite State Machines," in *IEEE NW Russia Young Researchers in Electrical and Electronic Engineering Conference*, 2019, pp. 356–359. doi: 10.1109/EIConRus.2019.8656866.

[7] S. Maqsood, M. Abbas, K. T. Miura, A. Majeed, and A. Iqbal, "Geometric Modeling and Applications of Generalized Blended Trigonometric Bézier Curves with Shape Parameters," *Adv Differ Equ*, vol. 2020, no. 1, Dec. 2020, doi: 10.1186/s13662-020-03001-4.

[8] A. T. Khomeiny, T. Restu Kusuma, A. N. Handayani, A. Prasetya Wibawa, and A. H. Supadmi Irianti, "Grading System Recommendations for Students using Fuzzy Mamdani Logic," in *4th International Conference on Vocational Education and Training, ICOVET 2020*, Sep. 2020, pp. 273–277. doi: 10.1109/ICOVET50258.2020.9230299.

[9] G. Galehantomo P.S, "Platform Comparison Between Games Console, Mobile Games And PC Games," *SISFORMA*, vol. 2, no. 1, p. 23, Nov. 2015, doi: 10.24167/sisforma.v2i1.407.

[10] N. R. Ramadhani, A. Mulyanto, and G. S. Niwanputri, "Designing Interaction and User Interface of Computational Thinking Digital Game for Children using User-Centered Design Approach," Sep. 2020. doi: 10.1109/ICAICTA49861.2020.9429049.

[11] K. R. dan T. Kementerian Pendidikan and Sekretariat Jenderal Pusat Prestasi Nasional, *Panduan Teknis Pelaksanaan Tingkat Nasional Lomba Debat Bahasa Indonesia dan National Schools Debating Championship*, vol. 1. 2021.

[12] S. Baydas and B. Karakas, "Defining a Curve as a Bezier Curve," *Journal of Taibah University for Science*, vol. 13, no. 1, pp. 522–528, Dec. 2019, doi: 10.1080/16583655.2019.1601913.

[13] D. M. Bourg and G. Seeman, *AI for Game Developers*, vol. 1. 2004.

[14] G. Ohashi, H. Seki, and M. Inuiguchi, "Knowledge Acquisition Using Fuzzy Inference Unified Max Operation and Its Application to a Medical Diagnosis System," in *Proceedings - 2018 IEEE International Conference on Systems, Man, and Cybernetics, SMC 2018*, Jan. 2019, pp. 1767–1772. doi: 10.1109/SMC.2018.00305.

[15] A. Ozdemir, K. F. Balbal, and B. C. Senel, "Mobile Devices Use in Analyzing the Engineering Students Attitude Towards Programming by Using a Fuzzy Logic Technique," *Computer Applications in Engineering Education*, vol. 29, no. 3, pp. 538–549, May 2021, doi: 10.1002/cae.22200.

[16] S. Sunjana, "Prediction of Production Using the Fuzzy Mamdani Inference Method," *International Journal of Advanced Science and Technology*, vol. 28, no. 6, pp. 136–139, 2019, [Online]. Available: https://www.researchgate.net/publication/356905699

[17] G. Selvachandran *et al.*, "A New Design of Mamdani Complex Fuzzy Inference System for Multiattribute Decision Making Problems," *IEEE Transactions on Fuzzy Systems*, vol. 29, no. 4, pp. 716–730, Apr. 2021, doi: 10.1109/TFUZZ.2019.2961350.

[18] E. C. dos Santos, P. Vilain, and D. H. Longo, "Poster: A systematic literature review to support the selection of user acceptance testing techniques," in *Proceedings - International Conference on Software Engineering*, May 2018, pp. 418–419. doi: 10.1145/3183440.3195036.