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Artificial intelligence development on “Golem” non-playable character in miner quest games with finite state machine method

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ABSTRACT

Digital educative game is an example of technology currently often used by kindergarten teachers to make topics or subjects easier for students to understand. By using the function of digital educational games, researchers plan to develop a "mining tour" game, with the objective that this game can convey knowledge or information about mining materials to early childhood. This game has obstacles that must be overcome or defeated, has a strong boss or monster at the end of each level and focuses on training to get mining results. This game was developed using the finite state machine method for non-playable characters (NPC). This method focuses on the player's choices when completing each mission in the game. In general, the appearance of this game uses references from Mario Bros. 2 game, and the quest to get many mining products (coal and nickel). The results of this study aim to determine how effective the "Miner" game is for kindergarten. Through live testing, we can evaluate the success of the "mining" game using the mined materials and develop the NPC system generated through the finite machine method.

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1. INTRODUCTION

Today, the massive development of technology, especially information technology, is blamed as the main factor that eliminates physical interaction between humans, such as the existence of electronic money cards is one of the media to help humans to be able to pay toll rates. In this case technology is one example of the development itself, in theory technology is a tool created by humans to support the needs of humans themselves in carrying out daily activities such as work, communication and so on. With the rapid development of technology, humans have become easier to do various things at one time and can be done anywhere without having to wait long and waste a lot of energy. In this case, understanding child development is an effort to teach or guide children so that they can increase their potential as optimally or maximally as possible [1]. With the rapid development of technology, it makes another demand for teachers or educators to deliver material or lessons to students in a more interesting way with the help of one of the technological media namely games [2]. Digital educative games are one of the game-based learning media or digital games that aim to teach children about technology that is increasingly developing without forgetting their obligations to learn as a student [3].

Today, there are a lot of games developed on many platforms, such as web, desktop, and mobile. Unfortunately, a few of them are educative. Many games are developed for adult people, and they are not appropriate to be played by the children. Many violent games have been linked to criminal activities [4].

Ramadhani has developed a serious game called as Crime Scene Investigation (CSI) which was designed for supporting student in studying digital forensics but is not appropriate for children [5].

One important aspect in this game is the existence of non-playable characters (NPC). NPC is important to make the games become more interactive. Many NPC is built based on several rules. Some games contain both antagonist NPC and protagonist NPC. In this game, NPS is divided into 2 parts, namely NPC by ordinary enemies like snakes, bats, and spiders, and NPC by boss like golem.

There are several problems that still exist in game development, especially for educational games. Many attractive games such as The Warriors, Tekken, And Grand Theft Auto (GTA) provide more elements of violence in the game, which can trigger feelings in children to commit similar actions in everyday life. Therefore game developers are expected to make games such as Time Gap: Mysteries Of The Lost Civilization And The Blacklist: Conspiracy, this game teaches players to recognize the names of items by the way players are asked to find items contained in the mission list, or game such as Scrabble Games, Words Of Wonders, And God Of Word, this game will require players to think and create a word with random letters that will be given by the computer randomly.

Based on these problems, this research aims to propose the development of a non-playable character known as Golem. This NPC is part of an educational game called Miner Quest. The scenario of the game is that players will be asked to look for mining products in the form of nickel and coal, which will be used to make batteries and materials for electricity generation, respectively. non-playable character behavior in this game is made using the finite state machine method.

In general, this work describes the game design process for the behavior of the main character and NPC, on the main character the behavior is designed in RC or remote controller, while for NPC behavior is designed using the finite state machine method for both ordinary NPC (snakes, spiders, and bats) or golem boss NPC. The testing process is carried out using 2 ways, namely functional tests, and user tests (interviews), in the functional test all NPC designed, especially the boss golem NPC, are in accordance with the initial design.

In the user test (interview) there are 3 stack holders involved including kindergarten children, parents and kindergarten teachers, the selection of these 3 stack holders is based on because the main target user for this work leads to kindergarten children, and to support the argument the parents of each child are needed because parents are people who take part and play a big role in the development of children, but also as supervisors of games and things that children access on gadgets that are played. For teachers, they are as important as parents, but teachers have their own role, namely as a teacher who will teach and introduce them to new things and how to respond to them, teachers are also evaluators who will evaluate and tell them if they are doing something that is not good or bad, as well as communicators who connect and inform parents of children's interests and talents.

2. LITERATURE REVIEW

2.1 Game Development

A game is a type of activity that can be played with players who try to achieve the objectives of the game by carrying out these activities according to certain rules in such a way that there are winners and losers, usually in a non-serious context or with the aim of recreational activities [6]. Playing alone can also improve brain skills when players must overcome conflicts or problems and find a way out of some game tasks. In addition, play can also stimulate children's cognitive development by improving the brain's ability to focus and train it to solve problems [7]. Games are competitive activities between players who interact with each other according to certain rules to achieve certain goals. To win the game, players must be able to come up with effective strategies or ways to solve problems [8].

In its development, the game genre began to be categorized into several genres, such as action games, educative games, platform games, adventure games, role playing games (RPG) and many more [9]. In this game there are 3 genres used, namely platform games, educative games, and adventure games. In its understanding, platform games are games whose gameplay only revolves around moving and jumping between obstacles and related objects, therefore this genre cannot stand alone and tends to be combined with other genres such as adventure games [10]. Adventure games are games that are presented in the form of game worlds and artificial environments. This genre requires players to interact with other NPC to solve problems for a story and objects in the game [11]. Educative games or educative games are games designed with the aim of providing education and teaching to players, this game also has the potential to build children's motivation and interest in learning [12].

Non-playable character (NPC) is an object or character in a game that can take the form of humans, animals, monsters, and others that cannot be controlled by the player but can act and perform actions in a way that the player seems to be able to control, but the NPC is actually controlled by the AI that allows the NPC to

walk in the game [13]. In general, NPCs can be defined as objects or characters that are fully controlled by the computer and cannot be played by the player [14].

Table 1. NPC description in several popular games.

No	Game	Protagonist role NPC	Antagonist role NPC
1	Mortal Kombat	Cole Young, Sub-Zero, Sonya Blade, Raiden, Liu Kang, and Kung Lao	Scorpion, Shang Tsung, Kano, Mileena, Goro, and Reptile
2	Mario Bros	Luigi, and Toad	Turtle, Bowser, and Koopa Troopas
3	Sonic The Hedghog	Sonic, Miles, and Echidna	Doctor Eggman, and Metal sonic
4	Contra	RD008, RC011, CX-1, CX-2, CX-3, CX-4, and Unnamed Commander	Gava, Java, Kimkoh, Gomeramos King, Red Valcon, Lance Bean, Searle, Lucia, etc.
5	Grand Theft Auto	Tommy Vercetti, Niko Bellic, Michael de Santa, Trevor Phillips, Franklin Clinton, and Claude	Frank Tenpenny, Steve Haines, Big Smoke, Darko Brevic, Devin Weston, Sony Forelli, and Dimitri Rascalov
6	Plant vs Zombie	Plants	Zombies
7	This work	-	Snake, Golem, Spider, and Bat

2.2 Mining Process in Indonesia

Indonesia is an archipelago that is very large in terms of territory. In addition to its large territory, Indonesia is also rich in natural resources from Sabang to Merauke, renewable natural resources such as water, wind, sunlight, air and so on. In addition to renewable natural resources, there are non-renewable natural resources such as natural resources derived from mines such as coal, nickel, and others [15]. In general, there are several kinds of mining products found in Indonesia, Table 2 is the mining products, benefits and areas that produce these mines.

Table 2. Mining Products in Indonesia

No	Mines	Benefit	Producing Areas
1	Gold	Currency, Aircraft Elements, Building Coatings, Investments, Electronic Devices, Medicine, and Cosmetics.	Papua, Nusa Tenggara Barat, Aceh, North of Sumatera, Sulawesi, West of Java, and Riau.
2	Coal	Power Generation, Natural Gas Generation, Paper Industry, Building Repair, Cement Industry, Steel and Aluminum Manufacturing Support.	West of Sumatera, South of Sumatera, West of Aceh, Papua, and South of Kalimantan.
3	Natural Oil	Fuel, Liquefied Gas Source, Petrochemical Industry, Polymer Production Source, Fiber Materials, and Polyurethane Materials.	Cilacap (Central of Java), Balikpapan (East of Kalimantan), Musi (South of Sumatera), Dumai (Riau), and Balongan (West of Java).
4	Bauxite	Aluminum Base Materials, Abrasive Materials, Crack Sealing, Food Packaging Manufacturing, Print and Copy Inks, Iron and Steel Making, Ceramic Manufacturing, and Tape Recording.	West of Kalimatan, Riau, Bangka Belitung, and North of Sumatera.
5	Copper	Heat Conduction, Metal Making, Jewelry, and Household Appliances.	Papua, Cikotok (Banten), Wonogiri (Central of Java), Sangkaropi (South of Sulawesi), and Silungkang (West of Sumatera).
6	Nickel	Manufacture of Stainless Steel, Steel Admixtures, Anti-rust Coatings, Automotive Industry, Battery Industry, Electroplating, Monel Manufacturing, Wire Manufacturing, Coin Manufacturing, and Catalysts.	South of Sulawesi (Sorowako, East of Luwu), Central of Sulawesi Morowali (), Kolaka (Central of Sulawesi), East of Halmahera (North of Maluku), and Gag Island (West of Papua).
7	Iron	Household Tool Making, Carpentry Tool Making, and Industrial Use.	Cilegon (Banten), Suwang Island (South of Sulawesi), Longkana (Central of Sulawesi), Verbeek Mountains (Central of Sulawesi), Lengkabana (South of Sulawesi), Tegak Mountain (Central of Sulawesi), Sebuku (South of Kalimantan), and Demawan (South of Kalimantan).

3. METHOD

3.1 Flowchart of Miner Quest game

In general, Miner Quest games consist of several states. Multiple state system is common in many games software. These states are main menu, play, tutorial, level 1, level 2, and high score. visualization and relation among states are presented in Figure 1. Meanwhile, the detailed description of each state is presented in Table 3.

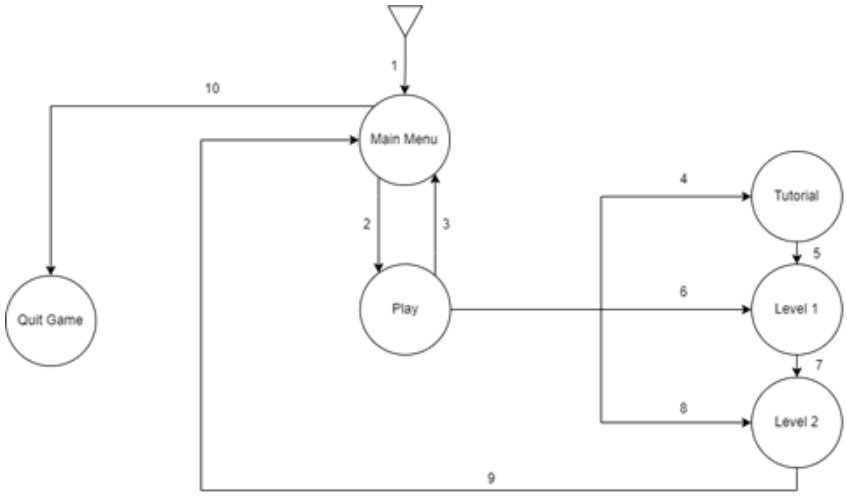

Figure 1. Miner Quest game state diagram

Table 3. Explanation of Miner Quest Game Flow Diagram

No	Event	Description of State
1	Player enters the game	Enter the main menu
2	Player selects play menu	Enter the play menu which contains levels in the game
3	Player selects back to menu	Enter the main menu
4	Player selects tutorial level	Enter the tutorial level
5	Player completes the tutorial level	Entering level 1
6	Player selects level 1	Entering level 1
7	Player completes level 1	Entering level 2
8	Player selects level 2	Entering level 2
9	Player completes level 2	Display the main menu
10	Player chooses quit game	Exit the game

3.2 Game Controller Design

The Miner Quest game is played using the keyboard as the main character controller and as a tool to move the select sign in the Miner Quest game menu section, in the selection of this game controller using the arrow control on the keyboard to move left / right and jump, and the "s" button to shoot / throw the axe. In addition, this controller is also suitable for the hand motor development of kindergarten children before they enter elementary school.

Table 4. Controller System for Miner Quest Game

Button	Function
	Selecting the Main Menu
Up arrow / ▲	To move the select area up
Down arrow / ▼	To move the select area down
Enter	To select the selected menu
Esc	Stop and exit the game
	In-Game
Up arrow / ▲	To make the MC jump
Left or right arrow (◄/►)	To make the MC move left or right
Keyboard 'S'	Attack / Throw axe
Esc	Pause the game and display the menu, resume the game

3.3 Character Design

In the Miner Quest game, there are several character designs that can be seen in Figure 2. The character design aims to increase the player's interest in playing this game. The main character in this game is a young man named Tito, he has a mission to collect coal which he will use as fuel for electricity, and nickel which will be used as material for making batteries, to complete the mission Tito must enter the cave to face the monsters that exist while completing the mission. at the end of the level Tito will face the golem boss, which is the last boss in this game, in the design golem is a large monster whose entire body is made of rocks and soil, therefore this boss is very suitable to be the last opponent of the main character in this game.

Figure 2. Character Design

3.4 Illustrations of The Game

(a) **(b)**

(c) **(d)**

Figure 3. Illustration of The Game (a) Tutorial, (b) Tutorial Truck Obstacle, (c) Level 1 Stage 1, (d) Last Level Boss Golem Obstacle

In Figure 3 are illustrations of the Miner Quest game, it can be seen in Figure 3.a is the initial condition of the game when the player plays the tutorial level and there are house properties and controller guides to support how to play. in Figure 3.b is an illustration of the player going through the truck obstacle, and if the player touches the truck, then the player's life point will be reduced by one, therefore the player is required to pass the truck from above. in Figure 3.c illustration of the main character display will take new coal and face the spider monster at level 1 stage 1. in Figure 3.d is the last level display and the main character will face the last obstacle which is against the boss golem.

3.5 Golem Boss NPC Behaviour Design

NPC Boss in the Miner Quest game acts as the last enemy king that prevents players from continuing to the next level or ending the game. The NPC boss golem behavior is designed using the Finite State Machine method, with the aim that the boss golem can move autonomously depending on the actions chosen by the player without having to be controlled using a controller. The following is a block diagram of the NPC boss golem behavior design in the Miner Quest game.

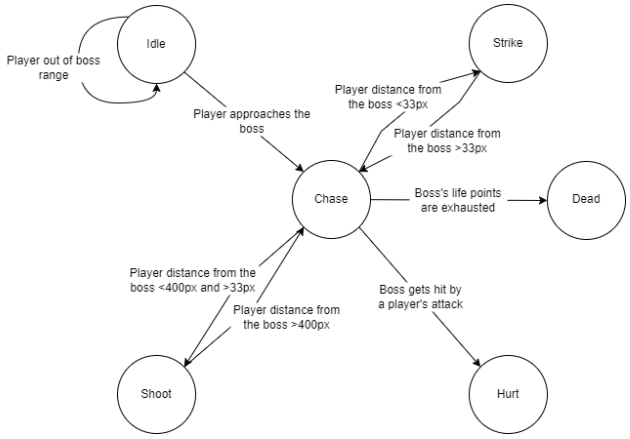

Figure 3. Non-playable character boss Golem state diagram

4. RESULTS AND DISCUSSION

NPC testing aims to find out whether the NPC made is in accordance with the state, input, or output produced with the design, testing the NPC can be seen in Table 5.

Table 5. NPC Boss Golem Testing

State	Behavior	Description
Idle	NPC is silent until it detects the player character	Suitable
Chase	Chasing player characters that enter the chase range	Suitable
Shoot	NPC shoots at the player when entering the shooting range	Suitable
Strike	NPC hits the player when entering the hitting range and exiting the shooting area	Suitable
Hurt	NPC gets a red effect when hit by an attack	Suitable
Dead	NPC life points run out and an explosion effect appears	Suitable

Table 6. User Testing Results

Code	Age (years)	Jobs	Statement
R1	7	kindergarten student	The game is good and exciting, some obstacles in the game are difficult to pass, the spider queen boss is more difficult than the golem boss, the game is very interesting and makes me want to play it again from start to finish.
R2	6	kindergarten student	None of the bosses in this game are difficult but if asked to choose, I would prefer to fight the golem boss.
R3	6	kindergarten student	The game is exciting, and it is more difficult to fight the golem boss because it is very strong, and I want to play again if there is a boss that is stronger than the golem boss.
R4	38	housewife/guardian of student r1	Respondent 1 often plays Roblox games, and adventure games, because he likes to dub the sound effects of the characters he plays.
R5	34	housewife / student guardian r2	Respondent 2 very often plays games on his cellphone; he likes to play games with the action-FPS (Frame Per Second) genre so that playing games like Mario Bros is easy for him and given a similar game he will have no difficulty playing it.

R6	53	kindergarten teacher	In this research we (teachers) do not know whether it will have an impact in which direction if the research is not carried out, in this case we also know that each parent will give games to their children with different frequencies such as once a week, every day and so on, and at school children will not be given games in the form of games to play. But if it is for research, please do so because giving the game once will not cause addiction, and addiction occurs when done repeatedly. For this game, children will be seen how quickly they respond to understanding the instructions given in the game, because every child is different, some can be told once and some can be told many times, besides that we teachers want to know how the results of using the game.

The pre-interview process is divided into several stages, the first stage is an exploratory process, the second stage is a discussion with the principal, the third stage is the determination of respondents by homeroom teachers. In the process of submitting and exploring pre-interviews, the response obtained from the homeroom representative (teacher) leaned towards positive, then the principal also authorized interview activities to all the required stack holders, namely students, student guardians and teachers. At the time of the interview, the homeroom teacher gave 3 students consisting of 2 boys and 1 girl, with abilities divided into 3 namely low, middle, and high, but the division of these abilities did not become a benchmark for them to be fast or slow in understanding the instructions given in the game.

Based on Table 6. and during the interview process 2 of the 3 children, namely R1 and R3, felt interested in and liked the Miner Quest game, and the other one, R2, felt bored and less interested in the Miner Quest game. Based on the response from R4 as the parent of R1 who likes this game, his son is fonder of and likes games with the adventure genre or adventure, besides that he also likes to provide voice-over or dubbing the voice of the character he plays like a game streamer on one of the YouTube channels. and the response from R5 as the parent of R1 who likes this game, his son is more fond of and likes games with the adventure genre, and the response from R5 as the parent of R3 who doesn't like this game, his son is more fond of and often plays FPS action games such as Call of Duty Mobile, Player Unknown's Battle Grounds (PUBG), and the like, therefore according to him games like this are too easy to play and get bored faster than the games he usually plays.

Based on Table 6. the response given by R6 as the teacher and homeroom teacher, they gave a positive response and were very supportive of this research because this could also be a benchmark for teachers in providing material and teaching to the students they care for, on the other hand to become evaluation material and suggestions that will be given by the teacher to each student's parents for the duration of the child playing the game because it will affect the child's future development.

The difficulties encountered during the interview process took place in the form of the small amount of time available to accompany each child while playing games and conduct interviews in the interval with the children's home time, besides the lack of support or support from one of the parents of students from R3 who did not want to conduct interviews so that the responses obtained from students to games based on the child's daily life could not be interpreted in detail.

5. CONCLUSION

Based on the exposure in this final project book, the golem boss npc development process has been demonstrated using the finite state machine (FSM) method, this book also shows that the FSM method is very suitable for developing NPC characters in general and specifically on bosses that have several actions.

Functional testing shows that the design and behavior of the golem boss NPC runs as designed, it can be seen in table 5. while user testing shows that in general the golem boss character can be well received, although there are some notes as follows:

1. Users want a mobile version of the game that can be played using a smartphone.
2. Seeing the development of games today, users feel that it would be more interesting if the game is also made in a 3-dimensional (3D) format.
3. Parents and teachers want attention regarding the duration of the game so that it is not too long to be played by children.

Based on the explanation above, there are several opportunities for further game development including:

1. In the next final project, the game can be made in 3D format and can be played using a smartphone.
2. Further game development should involve students who are engaged in art, so that the appearance can be made more attractive.
3. It is better if the next game development has a time limitation feature, so that children do not spend too much time playing games.

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