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2D VIDEO GAME DESIGN AND DEVELOPMENT USING FINITE STATE MACHINE METHOD

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ABSTRACT

Ever since the creation of world's first video game named "Tennis for Two" by a physicist named William Higinbotham with a purpose of stimulate learning and interest in physic, a lot of researcher started to research the effectiveness of video game as an educational media. One of the research by Richard E. Mayer shown that Celeste Pilegard has already suggested the idea of video game as a homework material. But a lot of researcher said that they wanted an evidence of the effectiveness of video game as educational purposes. The research conducted by Richard E. Mayer said that video game can be used as educational purpose even surpass the conventional media. Python is an object-orientated programming language created by Guido van Rossum with a philosophy to make user able to read source code easier. This programming language is popular to the point a lot of companies uses Python to create an application for their own company, because of this a lot of beginners wanted to study this language but struggle because of the difficulty of finding a free learning media for this programming language. The purpose of this research is to make the basic knowledge of Python Programming Language become even more accessible to everyone and to show the capability of the author in computer science department, specifically in video game development. The author uses Unity, Paint.NET and Bolt Visual Scripting as the tool to develop the video game in this research. The end result of this research is a video game titled "The Room" that developed using Unity as game engine and Finite State Machine as the method.
Keywords: *Finite State Machine, Unity, Game Development*

Introduction

In 1958, the world's first video game named "Tennis for Two" was created by a physicist named William Higinbotham with a purpose to stimulate learning and interest in physic. It was quite a success, to the point that people would queue in lengthy lines to play the game (Petter, 2017). Since then, video games' purpose has been evolved from to stimulate learning and interest to become one of the entertainment alternatives for both children and adult (Marzian & Qamal, 2017). Aside from entertainment purposes, a video game can still be used as educational purposes too (Mayer, 2019). One of video game example that has educational values is "Call of Duty: World at War" where it teaches the player a few real battle event such as "Battle of Stalingrad" and "Battle of Okinawa" (Rahimi et al., 2019). The idea of a video game as educational media has been already suggested by Celeste Pilegard where he suggested video game to be used as homework material (Mayer, 2019). But a lot of researchers said that they need evidence to test the effectiveness of video game as educational purposes (Mayer, 2019). A research conducted by Richard E. Mayer to review the current state of a video game as an educational purpose concluded that video game can be used as educational

purposes even better than conventional media (Mayer, 2019).

Python is an object-orientated programming language created by Guido van Rossum with a philosophy to make user able to read source code easier. This language is effective and popular to the point a lot of companies use Python to create an application for their own companies. Because of its popularity, a lot of beginners want to study this language, but a lot of them struggle because of the difficulty of finding free learning media for this programming language. Finite State Machine is a control system design method which describes the behaviour or work principle of a system using three things: state; event and action (Marzian & Qamal, 2017). This method has the same procedure as "if, else" which is why the Finite State Machine method is a good method to be used as video game development method

The difficulty of people to learn the Python programming language made us thought of an effective and fun alternative media to learn it. With that in mind, we decided to use a video game as educational media so that learning Python programming language becomes fun and interesting. Thus we choose "***2D Video Game Design and Development using Finite State Machine Method***" with a purpose of spreading the knowledge of Python programming language

Research Methodology

3.1. Research Flow

The research flow in this research is portrayed in Figure 3.1 which is as follow:

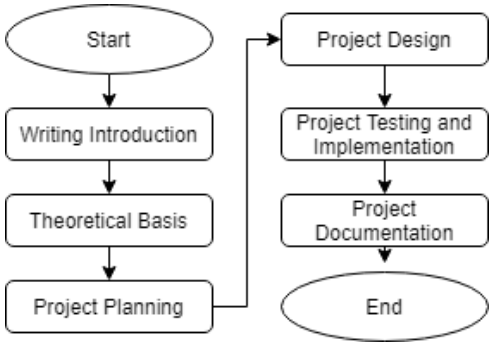

Figure 3. 1 Research Flow (Marzian & Qamal, 2017)

The explanation of the research flow that portrayed in Figure 3.1 are as the following:

3.1.1 Writing Introduction

The research started with writing an introduction to the problem to ensure that the reader is able to know the purpose of the project.

3.1.2 Theoretical Basis

The purpose of a theoretical basis in this step is to collect data and information such as theories, journals, method or even the approaches that have been developed and documented in form of books, etc. Those data and information are connected with how to develop a video game and how to apply the method that used in this research.

3.1.3 Project Planning

In the Project Planning phase, we will do the planning of what features the video game will have. From those features, we are going to make a storyboard, script and scenario of the video game that we going to develop with a Finite State Machine as the algorithm.

3.1.4 Project Design

In this phase, we are going to start the development of the video game based on the storyboard, script and the scenario that planned in the Project Planning phase. We are using Scrum as the development methodology.

3.1.5 Project Testing and Implementation.

After Project Design phase, we will be doing a test of our video game to ensure the video game will be having a little bug as possible. After that, we will be posting our video game into an indie game website named "itch.io"

No	Name	Description
1	Operating System	Windows 10 Pro 64-Bit (10.0, Build 18363)
2	System Model	X455LB
3	Processor	Intel® Core™ i7-5500U
4	Memory	12GB RAM

3.1.6 Project Documentation.

In this phase, we will be recording every progress that we have been making in the process of developing the video game.

3.2. **Research Tool**

In this research, the tools that we used as follow:

3.2.1. Unity 2019.2.13f1 (64-bit)

Unity is a cross-platform game engine designed to support and develops 2D and 3D video games that capable of making high-quality games, and design which is developed by Unity Technologies (Buyuksalih et al., 2017).

3.2.2. Hardware

The hardware used in this research is ASUS A455L Laptop with a specification as follows:

3.2.3. Paint.NET 4.3.7 (64-bit)

Paint.NET is a free image editor software that runs on Microsoft .NET 6 which is included in the program itself.

3.2.4. Bolt 1.4.13

Bolt is a visual scripting tool that developed by Ludiq in July of 2017. The tool uses nodes that reflect the codebase of C# language to create and execute logic (Knutsen, 2021)

3.3. **Research Method**

The method that used in this Research is Finite State Machine. Finite State Machine is a control system design methodology which describes the behaviour or work principle of a system using three things: state; event and action (Marzian & Qamal, 2017). The working principle of Finite State Machine is the same as a Decision Making principle, where the system can change state if the system gets input or a specific event, from the user input or even from within the system itself (Marzian & Qamal, 2017). This method will be applied in Research Planning, and Research Design. As an example of how this method work, this is the example schema of the Finite State Machine:

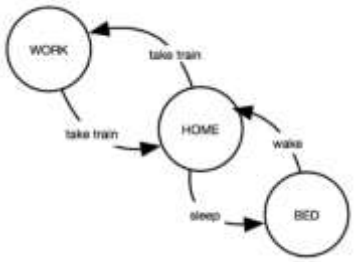

Figure 3.2 Finite State Machine Example

The explanation of this example as follows:

3.3.1. When receiving an event of "wake" while in "bed" state, the system changed state from "bed" to "home"

3.3.2. When receiving an event of "take train" while in "home" state, the system changed state from "home" to "work"

3.3.3. When receiving an event of "take train" while in "work" state, the system changed state from "work" to "home"

3.3.4. When receiving an event of "sleep" while in "home" state, the system changed state from "home" to "bed"

3.4. Development Methodology

The development methodology used in this research is Scrum. Scrum is an agile methodology that has a lot of beneficial out-come since it can reduce the time of production. The working principle of Scrum is by following the cycle of iteration itself (Kristiadi et al., 2020). The working principle of Scrum is portrayed in a Figure of 3.3 which is as shown as the following:

Figure 3.3 Scrum Methodology

The explanation of the scrum methodology as follow:

3.4.1. Product Backlog & Sprint Backlog

In this phase, we will list out all the need that we will be needed. If we already did a sprint, we will be consulting the backlog of the previous sprint and make a list of what we will be needing to do in the next sprint.

3.4.2. Sprint Planning

In this phase, we will be making the planning of what we need to do and list all the thing that we need to do in a 1 period of a sprint.

3.4.3. Implementation

In this phase, we will start doing the implementation from what we planned in the Sprint Planning phase. This phase can last a range of time period, such as 1 week to 4 weeks. When developing the video game, we will be also using a Finite State Machine as an algorithm.

3.4.4. Daily Scrum

Daily Scrum phase is a phase to check what thing that already done when doing the sprint. This phase is to make sure the project to stay-on-track.

3.4.5. Review

In this phase, we will be reviewing the result of the sprint to check what completed and what not completed in the sprint.

3.4.6. Retrospect

In this phase, we will be making a meeting between us and our supervisor to present the result of the sprint. The purpose of this phase is to get feedback from our supervisor

Result and Discussion

The creation of this video game is to spread the basic knowledge of Python Programming Language up-to "While-Loop" section using video game in the puzzle genre as a media. With this video game, the writers hopes that the basic knowledge in Python Programming Language can be spread wide.

Game Design

4.1.1. Game Flow Design

To simplify the game creation, the flow of this game consist of: start, interact with an object in room, solve quizzes, and move on the next room. By using Finite State Machine method, the visualization is shown at figure 4.1:

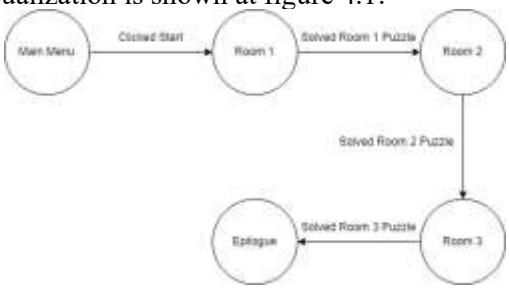

Figure 4.1 Game Flow

4.1.2. Game Level Design

The level in this game is divided to 3 parts: Room 1, Room 2 and Room 3. To help the player who doesn't have any knowledge in Python Programming Language, the writers implement a "hint book" that players can obtain in each room. The contents of each room is as the following:

4.1.2.1. Room 1 consist of six main props (bookshelf, wall-mounted clock, small desk, desk, potted plant and door), one puzzles and four quizzes from identifying each data type shown to asking the print result from the lines of codes that shown.

4.1.2.2. Room 2 consist of three main props (locker, sofa, door), and two quizzes from the previous room to asking about the result of an "If Statement" from the lines of codes that shown.

4.1.2.3. Room 3 consist of two main props (wall-mounted safe and door). And two quizzes from the previous room to asking about the result of a "While Loop" from the lines of codes that shown.

Asset Creation

In the making of assets, the writers used Paint.NET software to create a sprite that will be used for the creation of the video game. The sprites that created were "bookshelf", "wall-mounted clock", "table clock", "desk", "small desk", "potted plant", "door", "panel screen", "menu UI", "text area UI", "locker", "sofa", "wall-mounted safe".

Mechanic

The mechanic of the game is consist of interacting object by pressing the main mouse button toward an object such as bookshelf and etc.

The way player to play this game are mostly by using main mouse button, secondary mouse button and middle mouse button, but when the player is in quiz section, the player is told to use keyboard to input their answer to the quiz. The quizzes in this game has a random property so that every run in the game will result of different answer on the quizzes. The player can inspect

each object by pressing main mouse button and this will bring up the "close-up" view of the object. If the player wanted to get out from this view, they can do it by pressing either secondary mouse button or Esc key in keyboard.

Figure 4.2 Close-Up View in-game

Development

4.5.1 Development Issue

The issue with the development is mostly on what type of quiz or puzzle should be implemented in to the game to make sure that the player won't be frustrated or even cheat their way out from solving the quiz. The second issue with the development is on sprite creation since we aren't excel in multimedia section of information technology which end up making the sprite of the game looks minimalistic

4.5.2 Development Result

The result of the development are quite satisfying on the writer side since in the creation of this game the writer learned a lot of new information and way to create a video game. In the main menu scene, the player greeted by three objects: game title, and two buttons. Those buttons are "start" and "exit". When the player clicked on the "start" button, the game will switch to the Room 1 scene.

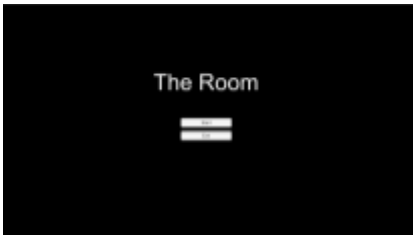

Figure 4.3 Main Menu

Room 1 scene consist of six main objects and three sub objects. In this room the hint book will explain about Python Programming Language from what is a Python, variable assignment, mathematical operators, print statement, data types and commenting in Python. The player can start the quiz anytime by pressing main mouse button on the door's second panel. There's a total of 4 Quiz that separate the Room 1 and Room 2 ranging from asking what is the value of certain variable, what is the data type of certain variable to what is the print result of certain print statement. Once the player done with Room 1, the player can choose to stay in this room or move to the next one.

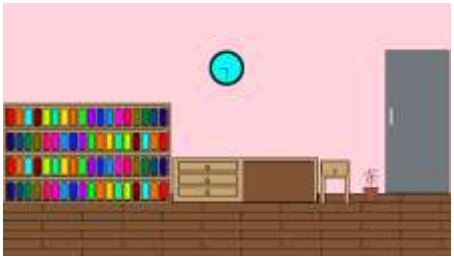

Figure 4.4 Room 1

Figure 4.5 Room 1's Door Quiz Example

Room 2 scene consist of three main objects and one sub objects. In this room, the hint book will explain about conditions, indentation and if statements.

The player can start the quiz anytime by pressing the main mouse button on the door's panel. There's a total of 2 quiz in this room, one quiz comes from the locker and the second quiz comes from the door. The locker quiz has a connection to the Room 1's Door Quiz while the Room 2's Door Quiz is about "If Statement".

Once the player cleared the quiz, the game will ask whether player want to move to the next

room or not.

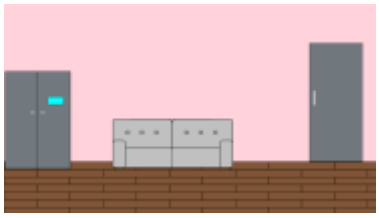

Figure 4.6 Room 2

Figure 4.7 Room 2's Locker Quiz Example

Figure 4.8 Room 2's Door Quiz Example

Room 3 scene consist of two main objects and one sub objects. In this room the hint book will explain about a looping in python programming language.

The quiz on this room can be started at any time by pressing main mouse button on the door's panel. In this room, there's a total of 2 quiz which is: Wall-Mounted Safe Quiz and Door Quiz. The Safe Quiz has a connection to the Room 2's Door Quiz while the Room 3's Door Quiz is about "While-Loop" statement.

Once the player cleared the quiz, they will be presented a decision whether they want to move out from the room or not.

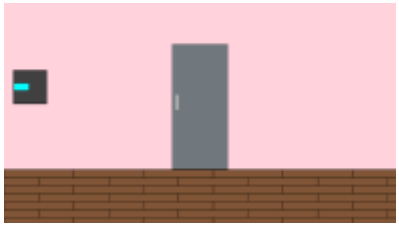

Figure 4.9 Room 3

Figure 4.10 Room 3's Safe Quiz

Figure 4.11 Room 3's Door Quiz

Epilogue scene is only consist of text box that ask the player whether they learn something or not and then they'll be presented a decision of returning to title or close the game.

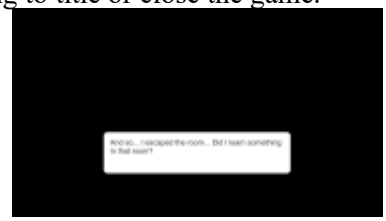

Figure 4.7 Epilogue

Testing and Implementation

After the video game named "The Room" completed, the writer and writer associate did a testing of the video game for bugs and opinions about the video game that has been created for seven days. The bug that founded in the video game were mostly a minor bug that has been fixed in the version 1.0.1 and the feedback from writer's associate said that the game are good enough but the fun factor is lower than expected. If the player didn't obtain the hint book, they will experience a minor confusion of how to solve the quiz. The finished product has been released in to a website named "itch.io", the specific link are

"https://shikazgames.itch.io/the-room" and people can download and give another feedback in that website.

Figure 4.8 Proof of Implementation

Limitation

As this is the first game that the writers created, most of the game parameters and coding are quite messy and the limited multimedia capability of the writers made the sprite of the game quite unappealing.

Conclusion

With the creation of the video game titled "The Room", the writers learned a lot more about Python Programming Language and game developing using Unity as the game engine.

Because the game content is about teaching player about Python Programming Language, the player can learn about Python Programming Language basic by playing the video game. With the existence of this game, the writers hope that there will be a lot more people can understand the basic on Python Programming Language. The knowledge that obtained in the process of development of the game, the writers learned a lot about Python Programming Language and game development using Unity as Game Engine. With these knowledge, there can be an improvement for the next game development.

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