

Night Market Escape in VR

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Abstract: Maze is a puzzle with network of paths or passage which one has to find a way. Maze game nowadays not provide a real life situation and player cannot fully experience real adventure that maze game can provide. Maze game nowadays need a gameplay that allow player to roam around the maze world and admire breath taking views through a virtual world while solving the maze. Night Market Escape in VR game was developed to provide virtual reality maze game with enjoyable first person view experience. This game was develop using the Game Development Life Cycle (GDLC) methodology. The GDLC consist of six phase which is Initiation phase, Pre-Production phase, Production Phase, Testing phase, Beta phase and Release Phase. All the phase will be used to develop the game except the release phase. At the end of this project, maze game can be played in the virtual world with the Malaysia night market environment. This game will provide enjoyable experience for user and can promote Malaysia to the world as this game are using Malaysia Night Market Environment.

Keywords: Maze, Night Market, Virtual Reality

1. Introduction

As games turn into a piece of everybody's life, it has numerous great impacts on our everyday life. A game is a system in which players engage in an artificial challenge, characterized by rules, that results in a quantifiable result [1]. There are many kind of games and one of them is a maze game. Maze is a puzzle with network of paths or passage which one has to find a way. The puzzle solving ability of the game expands ones creative ability. Maze game can make people learn various things like creativity, quick thinking, presence of mind and much more. Maze games help keep the mind active and build new brain cells that enhance the memory. By playing maze type of games, individual can improve their brain capacity to retain information.

Currently, there are many mobile maze games available. However, most of maze game available right now are not attractive enough and can be upgrade. There also not many mobile game available that have the Malaysian theme. Thus, in this project a mobile game named "Night Market Escape in VR" will be developed. It is a virtual reality maze game with the theme of Malaysian night market environment.

This game will be played in the virtual reality world with the environment of the night market in Malaysia. This game will be played in a first person view. The night market environment is like a maze and player have only one way to escape the night market. Player will roam around the night market and find the clues to help them escape the night market maze.

2. Materials and Methods

This section discusses the overview of the project domain which includes the theme of night market particularly its environment in Malaysia virtual reality and further exploration on similar type of virtual reality maze game that are related to the project.

2.1 Night Market

A Night Market is a gathering of temporary outdoor stalls operated by small business traders where products are displayed to be purchased [4]. Night Market are typically outdoor markets. Night market is a trading place during the evening, where small businesses offered a variety of cheap products and cooked food [3]. The night market gained their popularity steamed from the benefit they bring for the local citizens to do shopping for their household needs within their residential areas and bring an alternative shopping option [4]. Night Market makes people enjoy the diverse environment with their multiple choice goods and friendly and relaxed atmosphere. Among the reason night market gained their popularity are the atmosphere, the sight, the smell, the sound, and the food [4].

2.2 Maze Puzzle Game

Puzzles can be classified as problem-solving games, in which players have to clear the hurdle they confront. Solving puzzles helps players to cultivate logical thinking and to facilitate problem-solving strategies [2]. Puzzle's solution require the recognition of patterns and the have some kind of ordering. Puzzles genre can be divided into categories. There are many puzzle category which is tour puzzle, combination puzzle, mechanical puzzle, and many more. One of the puzzle game is a maze game. Maze game is categorized as a type of tour puzzle.

Maze is a path or collection of paths, typically from a start or one point to a goal. A maze is defined as a collection of paths and wall designed as a puzzle through which one has to find a way. Maze required finding a route through the maze from the start to finish. Mazes have a thousand years of ancient history, though the first mazes were not mazes at all, but labyrinths. The first recorded maze in history was the Egyptian Labyrinth. This labyrinths has evolve and turned into a traditional maze game.

2.3 Virtual Reality

Virtual Reality (VR) is a 3D environment, generated by computer that allows the user to interact with an alternate reality [5]. Virtual reality simulate a user's physical presence in a virtual or imaginary environment. Virtual reality can be categorized into the simulation of a real environment or the development of an imagined environment. Nowadays, virtual reality technology are used in various field such as military, healthcare, education and others.

An immersive virtual reality is a technology that gives the user the psychophysical experience of being surrounded by a virtual computer-generated environment [6]. Immersion is made possible with a combination of hardware, software, and interaction devices. In this game application, a virtual box headset were used to enable players to experience the virtual world. By using the virtual box headset, players will experience the virtual world in a stereoscopic view; whereby it gives a three-dimensional effect, adding an illusion of depth to a flat image [6].

2.4 Comparison between existing games and Night Market Escape in VR

Mobile game that have similarities with this project were analysed. Currently, there are many maze game available. Some of this game build in 3D while some were built in 2D. Two mobile game used to be compared to this project are VR Maze Game and Maze King.

VR Maze Game is a virtual reality maze game designed to be used with Google Cardboard headsets. The game is built on Android platform and is available to be freely downloaded in Google Play Store. The game uses a 3D environment with stereographic view. The background used in the game were green grass walls. The player are required to find their exit from the maze and in doing so, they are allowed to move their head to find their way around the maze. However, the game lacks a storyline which may cause the player to get bored easily. Moreover, the virtual environment too simple to keep the player interested with only the sound of birds chirping and footprints as background audio.

Maze King were developed as a 2D maze game. It is also built on Android platform and is available to be freely downloaded in Google Play Store. Maze King offers multiple level of play whereby the player has to complete their current level before being able to proceed to the next higher level. The game has both swipe and button control. Although the game has four different game mode which include stage mode, time mode and multiplayer mode and dark mode; the graphic design is fairly simple and the game environment is the same regardless of the mode chosen. The game control is easy however not challenging enough.

Night Market Escape is a virtual 3D maze game with a stereographic view. The game requires a virtual box headset in order to be played. It uses the local Malaysian theme with a Malaysian night market background. The storyline of the game starts with the player being lost at the night market. The player needs to find the way to exit the night market. To find their way out, the player needs to find the clues placed around the night market.

The game can be paused and then continued at any time. Game can be continued at the last save place or start a new game. It also has a save button that can be used to save the game. The game comes with 3 difficulty levels. Each level has a different maze structure and night market environment. There are no time limit set to complete the game, but the time used to complete the game will be recorded and the best time recorded will be listed on the leader board.

Table 1 shows the comparison between existing games and Night Market Escape in VR. All three games uses Android platform. Both VR maze game and Night Market Escape in VR uses 3D technology while Maze King uses 2D technology. Although using 3D virtual environment, the metaphor in VR maze game metaphors is fairly simple as compared to the environment in Night Market Escape in VR which depicts Malaysian night market scene. Every game has specific goals to be completed but only the Night Market Escape in VR has a storyline that bring more enjoyable experience while playing the game.

Table 1: Comparison of game features

Features	VR Maze Game	Maze King	Night Market Escape in VR
Platform	Android	Android	Android
Dimension	3D	2D	3D
Goals	Find the exit in the labyrinth	Navigate character through maze	Find the way to exit night market
Storyline	No Storyline	No Storyline	Different backstory for every level
Metaphors	Top view	Grass wall	Malaysian Night Market
Time	No time	Time Limit	Time Recorded

3. Methodology

Methodology is the study of method or technique used in problem solving that involved in some field [7]. A game is a kind of software which provides entertainment [8]. While developing a game, it is not enough by simply adopting the software development life cycle (SDLC) as it faces several challenges [8], so game development uses a kind of specific approach. Night Market Escape in VR is developed using Game Development Life Cycle (GDLC) [9]. There are six phases in this methodology which are initiation, pre-production, production, testing, beta and release. All of the phases was used to develop the game except for the release phase. Figure 1 shows the GDLC methodology used in the development of this game. The summary of activities and outcome for each of the phases are shown in the Table 2.

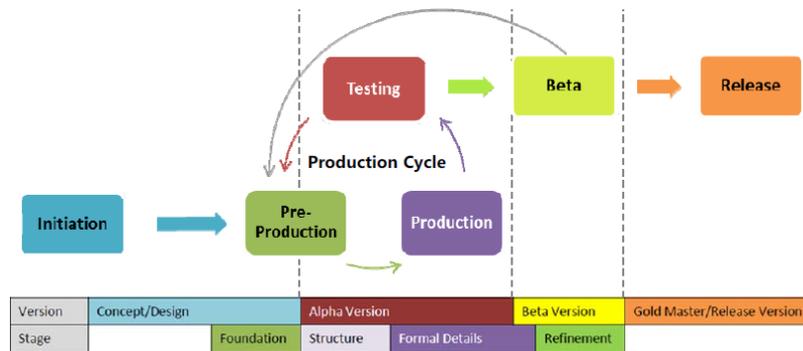


Figure 1: GDLC Methodology [10]

Table 2: GDLC phase summary

Phase	Activity	Outcome
Initiation	All related thing to the game will be studied. Its include user review, idea generation and hardware and software requirement.	Problem, objective, scope, methodology will be use, expected result, significant project, project plan (GanttChart), gameplay, identification of maze environment, platform and software and hardware requirement were identified.
Pre-Production	Sketch the storyboard and game design.	Storyboard, Game content, game design, game walkthrough, storyline, character, challenge, fun factor were designed.
Production	Game asset development, developing the source code, adding new feature, improving overall performance, and fixing the bugs	Game asset created, source code generated, new feature improvement, overall performance upgrade and bugs fixing performed.
Testing	Testing game usability and playability	Report on usability testing, bugs encountered and redevelopment decision analysis
Beta	Game test by third-party or external tester	Report on bugs and user feedback

4. Analysis and Design

Two phases of GDLC are involved in this phase. These phases are initiation phase and pre-production phase. In the initiation phase, all related thing to the project were studied. It includes user review, idea generation and hardware and software requirement. For the pre-production phase, the activity involved are sketching the storyboard and producing the game design.

4.1 Analysis

Analysis involved in this project are generating game concept, defining target audience, target platform, and hardware and software requirement.

i. Generating Game Concept

Malone [11] has listed three main characteristics that makes a game fun to learn. They should provide the appropriate level of challenge, use fantasy and abstractions to make it more interesting, and can trigger the player's curiosity. Game concept is important to makes the game fun to learn. Before starting to develop the game, game concept must be determined first. For this project, similar games review was conducted by searching on Google Play to determine the game concept. The result of this review are the existing mobile games is not fun enough to play and does not have Malaysia's local content. Local content is important to reflect Malaysian culture and values. Thus for this project, Malaysian night market environment was applied in the game.

ii. Defining Target Audience

Night Market Escape in VR was developed for public users. However, this mobile game is more suitable for user with the age of 18 until 30 as this games requires critical and logical thinking to complete the game.

iii. Defining Target Platform

There are many digital platform to develop a mobile game such as Android, iOS, and Windows Phone. For this project, the game was develop in Android platform because Android is the most popular mobile operating system.

iv. Defining Game Design Technique

The designer's creative skill is important while defining the game design [12]. Defining the game design is an important step that will decide how user will interact with the game. Game design creates goals, rules and challenges that produces desirable interactions between the game and users. For this project, the game used first person view with stereoscopic view in virtual reality.

v. Hardware and Software Requirement

Analysis of software and hardware is important to ensure that development can proceed smoothly and target users will be able to play the game on their device. The software requirements identified for the development of the game includes Unity, Blender, Adobe Photoshop, Adobe Illustrator and Mono Develop. Appendix A lists the hardware requirement for both the end-user and developer.

4.2 Design

As part of the design activities, navigational structure, flowchart and storyboard of the game were created. Navigational structure functions as a guide to the user through all the interfaces of the game. For Night Marker Escape game uses the hierarchical structure as to navigate user through the similar branches of a tree structure. Flowchart were created to show the detailed flow of the game. Figure 2 shows the main interface design of the game in stereoscopic view.



Figure 2: Main interface design of Night Market Escape in VR

5. Implementation and Testing

Application development process include the process of assets and coding development for the game application. Testing will be conducted once the game application is developed.

5.1 Assets Development

As the theme of the game is a night market in Malaysia, the assets development include models of objects that simulates a night market environment. These includes night market stalls, seller, shoppers who comes of the night market and etc. To make sure the virtual reality world is more attractive, a variety of 3D objects are used. The 3D objects used are built using Blender and Unity applications. Various aspects are taken into account while building this 3D object. Among them are the themes, the objects size and object colours. A finished 3D object is then added with texture for realism. Figure 3 shows examples of assets created for the game.

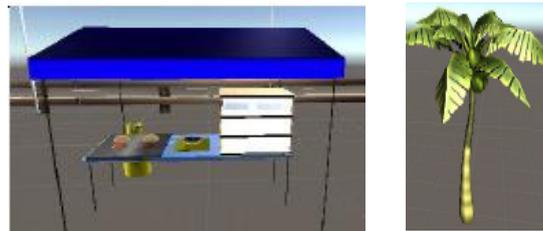


Figure 3: Examples of game assets

5.2 Coding Development

The function prototypes and scripting of the objects were developed using C# programming language. The scripting is extremely important to the functionality, interaction and navigation of the application. It is also used to move the camera, calculate the time, movement from scene to scene, audio control and triggering events. Among the triggered events is to activate and deactivate the object, trigger the clue and pause the game. Figure 4 shows the code to activate and deactivate an object. This code is used to trigger whether to activate the object or deactivate it.

```
public class ObjectActive : MonoBehaviour {
    public void DeactiveObject() {
        gameObject.SetActive(false);
    }
    public void ActivateObject() {
        gameObject.SetActive(true);
    }
}
```

Figure 4: Code to activate and deactivate object

The game is developed as a virtual reality game with a first person view. The player will control the camera by moving their head while using the Virtual Reality Box. Figure show 5 shows the program code to move the camera. Using this code, the player will move the head together with the virtual box to look around. Players can move the camera forward by lowering the head. The code will detect the degree of the camera to start moving forward. The degree of camera can be changed according to the angle of the phone.

```

if (walking) {
    if (vrCamera.eulerAngles.x >= toggleAngle &&
vrCamera.eulerAngles.x < 90.0f) {
moveForward = true;
soundWalking.SetActive (true);
    } else {
moveForward = false;
soundWalking.SetActive (false);
    }
    if (moveForward) {
        Vector3 forward =
vrCamera.TransformDirection (Vector3.forward);
cc.SimpleMove (forward * speed);
    }
}

```

Figure 5: Code for camera movement

Lastly, the game application is published in *.apk* file format. The process of building an APK file involves several steps. The first step is to download and install the external tool for Android which are Software Development Kit (SDK), Java Development Kit (JDK) and Native Development Kit (NDK). After downloading and installing Android external tools, this game can be built into the APK file. During the building process, Android platform was selected to save the project to APK. The APK file that has been stored in the phone memory needs to be installed first before it can be used. After completing the installation of APK file, the game application requires a virtual headset to play. The installation of the phone into the virtual headset is very easy. The player only have to insert the phone into the virtual headset and wear the virtual headset.

5.3 Testing

The game application was successfully built. User testing was carried out to evaluate three variables: users' acceptance level towards the game, functionality level and performance level of the game. This testing involved 24 target users, involving both genders and all races. The testing was conducted at UTHM in Parit Raja, Batu Pahat.

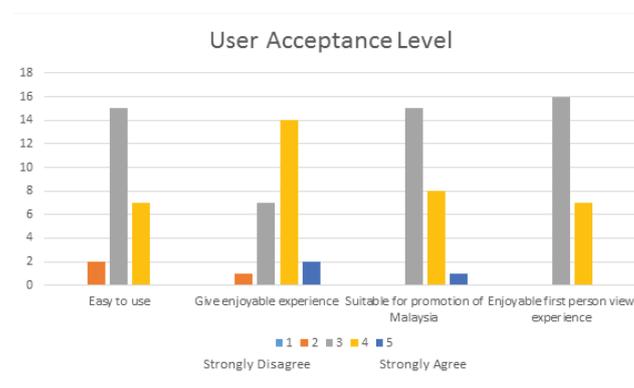


Figure 6: User acceptance level of game application

Figure 6 shows that 66.7% (16) respondents agreed that the game provides an enjoyable experience. Also, 37.5% (9) respondents agreed that the virtual environment of the game has a Malaysian feel. Conversely, 15 respondents were undecided as to whether the game conveys a true Malaysian feel of

the night market scene. Interestingly, 95.8% (23) respondents agreed and strongly agreed that the game provides an enjoyable experience of a first person view. Meanwhile, Figure 7 displays user's acceptance of the game's functionality. Most of the respondents (83.3%) agreed that the virtual reality interaction of the game works well. Besides that, most of the respondents agreed (83.3%) that the control buttons work perfectly in the game. Moreover, most of the respondents agreed (91.6%) that the audio can be clearly heard in the game.

User acceptance level of the game performance is shown in Figure 8. 41% of the respondents finds that the game is unstable when played on various smartphones. This may be due to the difference in the phone specifications, which consequently affects the navigation control. For the presentation of information and transition between scenes, 50% of users were undecided. Unaccustomed to stereoscopic view could be a contributing factor. Nevertheless, 41.6% of respondents feels that the application is good.

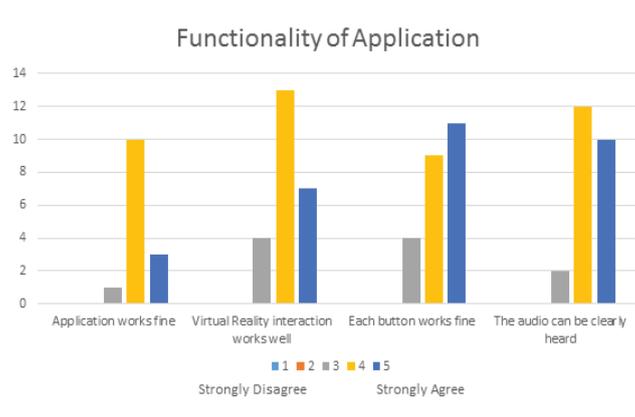


Figure 7: Functionality of game application

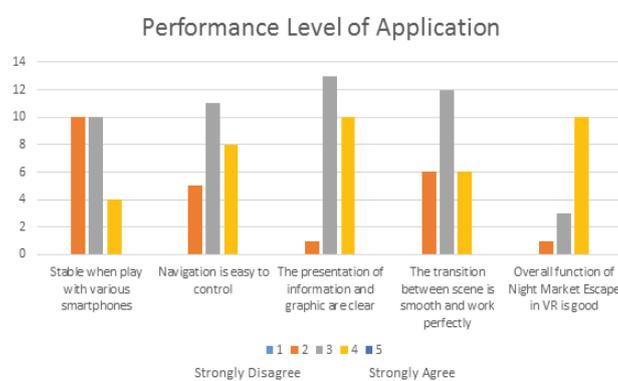


Figure 8: Performance of game application

6. Conclusion

As conclusion, Night Market Escape in VR has been developed successfully and achieved all the objectives of this project. The advantages of the game are it allows the interaction with virtual objects and player is freely to explore the scene by themselves. The game provides users the experience of roaming a night market in Malaysia. Nevertheless, the limitation of the game were also identified as insufficient audio effects, unnatural animation and lagging due to hardware restrictions.

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Appendix A

Tables A1 and A2 shows the hardware requirement for both the end-user and developer

Table A1: User's hardware requirement

Hardware	Specification	Functionality
Android Device	<ul style="list-style-type: none"> • 1.5 GHz or faster processor • 3 GB RAM or more 	To play the game
Virtual Box	<ul style="list-style-type: none"> • Android 4.4 'Kit Kat' or higher • 3D Virtual Box 	To play the game in Virtual Reality

Table A2: Developer's hardware requirement

Hardware	Specification	Functionality
Laptop	<ul style="list-style-type: none"> • Intel Core i5 GHz or faster processor • 4GB RAM or more 	To developed the game
Android Device	<ul style="list-style-type: none"> • 1.5 GHz or faster processor • 3 GB RAM or more 	To test the game
Mouse	<ul style="list-style-type: none"> • Android 4.4 'Kit Kat' or higher • Optical Mouse 	Game editing and building model in Blender
Keyboard	<ul style="list-style-type: none"> • Built-in keyboard 	Typing
Virtual Box	<ul style="list-style-type: none"> • 3D Virtual Box 	Test the game in Virtual Reality

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