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Noodles VR: A 3D Cooking Simulation

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Abstract

Noodles from Southeast Asia, especially those originating in Malaysia, Indonesia, and Thailand, possess considerable cultural importance. While some people continue to use conventional learning techniques, the launch of Noodles VR can rise their passion for Southeast Asian food. This project seeks to create Noodles VR, a virtual reality application that integrates Interactive Cooking Simulation with Cultural Education. Targeting young learners and food enthusiasts, the application was developed using the TRES-D methodology, following a user-centered and iterative approach. Noodles VR allows users to acquire knowledge about food preparation while exploring the cultural importance of several noodle meals. Usability was assessed using user acceptance testing employing the System Usability Scale (SUS), yielding an average score of 84.38, classified as "Excellent" and assigned a grade of "B" on the scale. The results indicate that Noodles VR effectively promotes user engagement and supports the preservation of Southeast Asian culinary traditions through immersive digital learning.

1. Introduction

Noodle dishes are fundamental components of Southeast Asian cuisine, particularly in Malaysia, Thailand, and Indonesia. These dishes hold cultural significance, showcasing the many ingredients and culinary techniques common in Southeast Asia. In today's fast-paced world, there is a growing interest in learning how to make these dishes, especially among younger generations and foodies. Traditional learning approaches, such as physical culinary lessons or video tutorials, are not necessarily effective or interesting, especially for those who prefer a more immersed experience [1].

Several issues have arisen because of the lack of an immersive learning environment. Young learners and food enthusiasts may lose interest in learning about Southeast Asian culinary traditions, resulting in an ongoing decrease in cultural heritage preservation. Furthermore, traditional culinary methods, ingredients, and geographical differences may not be properly grasped or enjoyed using passive learning tools. The lack of an interesting teaching tool further restricts access to this knowledge for those who are not physically close to cooking schools or food specialists [2].

Therefore, this project aims to design Noodles VR application that simulates the preparation of noodle dishes from Malaysia, Thailand, and Indonesia, to develop Noodles VR application by using VR technology, and to evaluate the usability and user acceptance test on the develop application. The developed application is designed for users aged 13 and above who are interested in food and culture. The Noodles VR will have two main functional modules. First, the Cultural Education will provide educational content detailing the background, and ingredients of each dish, enhancing user's knowledge behind the dishes. Second, the Interactive Cooking Simulation will guide users step-by-step through the process of preparing noodle dishes in a virtual kitchen, providing an authentic hands-on experience.

The "Noodles VR" application provides several significant features. For starters, it contributes to the preservation of Southeast Asian culinary history by making the cultural and historical features of noodle dishes more accessible and appealing to young people. For education, this VR technology offers a novel, interactive way to teach cooking skills and cultural information, which is especially useful for individuals who cannot attend regular culinary lessons.

The rest of the paper is arranged as follows: Section 2 covers the domain of study, the technology used, and the result of the comparative analysis. Section 3 describes the TRES-D methodology that has been chosen to be used in this project, as well as the output of the analysis and design phases of this project. Furthermore, Section 4 discusses the result and discussion, while Section 5 states the conclusion of the current progress.

2. Related Work

This section discusses the background of the study, the technology used, and the result of the comparative analysis.

2.1 Southeast Asian noodle

Noodles from Southeast Asia, a regional culinary essential, possess cultural and historical importance. Renowned dishes such as Mi Goreng from Malaysia, Pad Thai from Thailand, and Indomie Goreng from Indonesia are celebrated for their unique flavors and ingredients. Younger generations are becoming disenchanted with traditional cooking skills due to a heightened dependence on convenience meals and insufficient exposure to culinary traditions. In the context of modernization and global influences, preserving the skills and expertise necessary for preparing traditional cuisine has become challenging [3]. Engaging younger audiences and food enthusiasts in a pertinent and captivating manner is essential for the preservation of these culinary traditions. The primary resources for mastering the preparation of Southeast Asian noodles are cookbooks, online tutorials, and in-person culinary classes. While these technologies provide essential information, they often lack engagement and participation. Recipe blogs and video lessons provide unidirectional communication with minimal user engagement. Similarly, despite its engagement, actual culinary sessions are often inaccessible due to constraints of time, finances, or geographical location. When cultural context and narrative are equally essential for understanding cuisine, these methods may fail to completely engage students in the learning process. A platform that integrates education and cultural immersion is necessary. A virtual reality (VR) method could address these deficiencies by offering an immersive environment where users can practice techniques and explore the historical context of the dishes in an interactive manner [4].

2.2 Virtual Reality

This project uses Virtual Reality (VR), specifically fully immersive VR, as the primary technology to create an engaging and dynamic learning experience. VR is a simulated world built with computer-generated visuals and sound to mirror actual or imagined circumstances [5]. Fully immersive VR generates a compelling sense of presence by allowing users to engage with these surroundings via specialized equipment such as VR headsets and motion controllers, making it ideal for hands-on learning in sectors such as culinary arts and cultural education. Fully immersive VR implies 360-degree visuals, real-time interactivity, and precise audio-visual feedback, giving users a realistic sensation of immersion [5]. This technology's features include its capacity to thoroughly engage users while providing a realistic and distraction-free environment for skill acquisition. However, it does have limits, such as expensive hardware costs, significant computational requirements, and the possibility of motion sickness in some users. Several existing apps demonstrate the usage of fully immersive VR for educational purposes. For example, [6] simulates a cooking setting and teaches users numerous recipes through step-by-step interaction in a virtual kitchen. Similarly, [7] gamifies cooking by allowing users to collaborate in meal preparation while learning techniques in a fun environment. Unfortunately, these apps fail to focus on unique cultural and culinary traditions, because they are not focused on Southeast Asian dishes, but the proposed app fills this gap by preserving and promoting these dishes via an entertaining, fully immersive interface.

2.3 Comparative Analysis

Comparative analyses were conducted on three related applications to the proposed system. The three applications are Cooking Simulator VR [6], Cook-Out: A Sandwich Tale [7], and Clash of Chefs VR [8], as shown in Fig. 1(a), (b), and (c), respectively. Table 1 shows the result of the comparative analysis. The comparison is based on nine different features of the application. the first feature that is being discusses is the core focus, followed by the immersion, educational content, cultural representation, gameplay approach, game mechanics, target audience, strength, and limitation.

(a) (b) (c)

Fig.1 *(a) Cooking simulator VR [6]; (b) Cook-Out: Sandwich Tale [7]; (c) Clash of Chefs VR [8]*

Table 1 *Comparison between existing applications and developed applications*

Features	Cooking Simulator VR	Cook-Out: A Sandwich Tale	Clash of Chefs VR	Southeast Noodle VR
Core Focus	Realistic cooking simulation	Multiplayer sandwich-making game	Competitive chef gameplay	Southeast Asian noodle cooking and culture
Immersion	High; fully immersive VR	Moderate; focused on gameplay	High; competitive environment	High; includes cultural storytelling
Educational Content	Minimal	Limited to basic cooking steps	None	Comprehensive, emphasizing culinary skills and heritage
Cultural Representation	None	None	None	In-depth, showcasing Southeast Asian dish
Gameplay Approach	Single-player, realistic tasks	Team-based, casual gameplay	Competitive, time-based gameplay	Single-player, realistic tasks
Game mechanics	Realistic physics-based mechanics enable users to chop, fry, bake, and do other cooking procedures in a detailed virtual kitchen.	Cooperative gaming with a focus on teamwork, communication, and coordination within time limits.	Competing in real-time cookery duels, participants compete to accomplish orders precisely and efficiently.	Realistic single-player tasks that simulate the preparation of Southeast Asian noodle dishes
Target Audience	Cooking enthusiasts, gamers	Casual players, party game fans	Competitive players, gamers	Younger learners, food enthusiasts, and cultural learners
Strengths	Realistic visuals and physics	Fun, team-based gameplay	High-paced, competitive gameplay	Culturally immersive and educational
Limitations	Limited cultural depth, no learning progression	Simplistic content, minimal education focus	Lacks cultural and educational depth	Requires VR setup, may need diverse recipe database

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3. Methodology

Noodles VR is a 3D cooking simulation application that simulate preparation of noodle dishes using virtual reality. So, TRES-D (Three-Dimensional User Interface Development) methodology [9] is chosen to develop this application as shown in Figure 2. TRES-D methodology consist of six phases which are initial requirements, understand requirements, concept design, iterative design, building and implementation, and lastly deploy and maintenance. Table 2 summarizes the results of the six steps of the TRES-D approach.

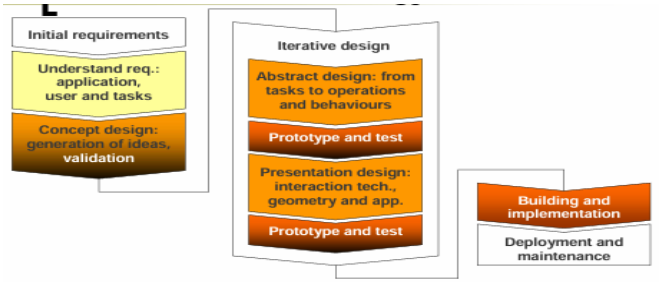


Fig. 2 *TRES-D Methodology [9]*

3.1 Initial Requirement Phase

This phase is focused on gathering basic ideas and expectations from Subject Matter Expert (SME). This phase involves brainstorming sessions, SME interviews, to discover the application's essential features, goals, and limitations. The goal is to have a broad grasp of the app's purpose and scope. As the result of initial requirements checklist has been created, as shown in Table 3. In this phase, objective, problem statement, expected outcome, and project significance were addressed and established. The necessary information is determined before designing and developing Noodles VR.

Table 2 *Initial requirement checklist*

Item	Southeast Noodle VR
Type of application	3D Virtual Reality Application
Target device	VR headsets compatible with PC platforms
Target users	Users aged 13 to 25, particularly those interested in Southeast Asian culture and culinary experiences
Graphic User Interface (GUI)	Engaging graphic design with simple navigation ideal for VR experiences.
Images	High-quality images of Southeast Asian ingredients, and cultural features.
3D model	Detailed 3D representations of culinary tools and noodle preparation operations.
Animation	Ingredient interactions, and storytelling moments
Audio	traditional background music and ambient sounds
Application synopsis	*Southeast Noodle VR* is a 3D Virtual Reality Application designed to provide an immersive cultural and culinary learning experience. The app features traditional noodle dishes from Malaysia, Thailand, and Indonesia, allowing users to explore their cultural significance and preparation processes. Through interactive cooking simulations and storytelling, users gain hands-on experience in preparing iconic dishes while learning about their cultural contexts. The application aims to entertain, educate, and inspire appreciation for Southeast Asian cuisine in a visually rich and engaging VR environment.

In this phase, functional and non-functional requirements to provide an information for the proposed application. The functional requirements and non-functional requirements were presented in table 6 and table 7 respectively.

Table 3 *Functional requirements*

Functional Requirements	Module	Description
Autonomous system activities	Cultural Education Modules	Provide detailed information about the cultural background and significance of noodle dishes from Malaysia, Indonesia, and Thailand.
	Interactive Cooking Simulation	Allow users to practice cooking noodle dishes step-by-step in a virtual environment using immersive tools like VR controllers.
	Audio	Incorporate culturally appropriate audio cues, such as background music to enhance the learning experience.
Provide learning content	Cultural Education Modules	Present engaging and interactive educational content, such as historical facts and cultural stories related to the selected noodle dishes.
	Interactive Cooking Simulation	Guide users through virtual cooking tasks, including preparing ingredients, cooking, and plating.
User interaction support	Main interface	Ensure an intuitive user interface for navigating through the application's features, including menu selection.
	Main Menu	Provide easy access to the main features of the application, such as dish selection, tutorials, and cultural education.
	Cultural Education Modules	Offer an interface for users to explore cultural stories and background information on dishes, presented through text, images, and videos
User interaction support	Interactive Cooking Simulation	Design an interactive interface for users to perform virtual cooking actions, such as chopping, stirring, and frying, with VR tools and controls.

Table 3 shown functional requirements for Noodles VR application, the requirements are autonomous system activities, provide learning content, and user interaction support.

Table 4 *non-functional requirements*

Non-Functional Requirements	Description
Performance	The system should provide a smooth and responsive VR experience, maintaining a minimum frame rate of 60 FPS to ensure user comfort and immersion.
Operation	The application must be compatible with standard VR hardware and run seamlessly on PC-based VR platforms with minimal setup and installation requirements.
Cultural	The content must accurately represent the cultural practices and significance of noodle dishes from Malaysia, Indonesia, and Thailand to preserve authenticity.
Legal	Users should only be allowed to view the application's content and not edit it.
Usability	The interface must be intuitive and user-friendly, accommodating users aged 13 and above, with clear navigation, instructional guides, and accessible controls.

Table 4 outline the non-functional requirements for VR application, it consist of performance, operation, cultural, legal, and usability. Table 5 shown hardware requirements for users and table 6 shown hardware and software requirements for the developer.

Table 5 *Hardware requirements for the users*

Requirements	Item	Description
Hardware	Computer	Allow users to install and run the app. The minimum specifications are as follows: • Operating System: Windows 10(minimum) • Processer: Multi-Core Processor • Graphics: NVIDIA GeForce RTX Series (Recommended) • Installed Memory (RAM): 8.00GB • Storage: Sufficient storage space for download application
	VR headset	Allow users to explore the virtual world. • RAM: 4GB and above • Storage: 64GB and above • Video output: DisplayPort 1.2 or newer • Operating system: Windows 10 or above • USB port: 1x USB 3.0 or newer

Table 6 *Hardware and software requirements for the developer*

Requirements	Item	Description
Hardware	PC (HP Omen)	Allow the developer to work with software to create the app. The specifications are as follows: • Operating System: Windows 11 • Processer: AMD Ryzen 4 5600G with Radeon Graphics • Graphics: NVIDIA GeForce RTX 3060 Ti • Installed Memory (RAM): 32 GB • Storage: 1Tera GB SSD, 2 Tera GB HDD.
	VR headset	Allow developer to test the VR environment. • RAM: 4GB and above • Storage: 64GB and above • Video output: DisplayPort 1.2 or newer • Operating system: Windows 10 or above USB port: 1x USB 3.0 or newer
	Input-output devices	Allow the developers to communicate with the computer. • Keyboard • Mouse • Headphone
Software	Canva	To design storyboard.
	Blender	To create the 3D assets.
	Unity	To integrate the assets of the application.
	Visual Studio 2019	To write the C# script for the application.

3.2 Understand Requirement Phase

This phase involves refining the initial ideas into detailed and actionable requirements [10]. This phase involves analyzing the application structure. Table 4 shows Key Scenario List of the proposed application. Table 7 shows a list of key scenarios, involving SME to make a better analysis. An interview session has been conducted with SME Mr Afif Naim bin Abd Rani, who is teaching culinary at FPTV in UTHM and has 3 years of experience. The interview was transcribed and can be found in **Appendix A**.

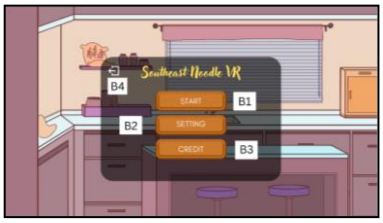
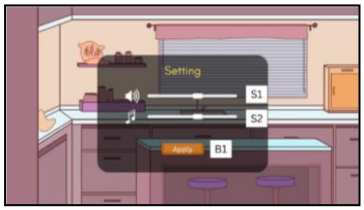
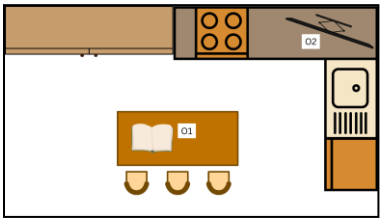
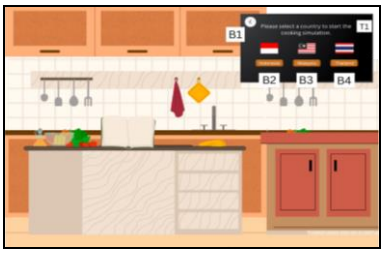
Table 7 *Key Scenario List*

Subject Matter Expert Aspect	Key Scenario
Cultural Diversity	Explore Dishes from Malaysia, Indonesia, and Thailand.
Immersive Learning	Learn about the origin, ingredients and how to cook each dish
User Interaction	Interact with virtual objects like food ingredients
Education Enhancement	Information about dishes and their origin
Multisensory Experience	Immerse yourself in background music that improves the cooking ambiance.

3.3 Concept Design Phase

Here, the project transitions from ideas to initial visual and functional representations [11]. Activities include designing conceptual models of the application, such as storyboards. Storyboards are visual tools that illustrate a user's experience with a product or service [12]. A storyboard has been created as visualization of Noodles VR application and the storyboard shown in **Table 8**.

Table 8 *Storyboard*

Interfaces	Description	Interfaces	Description
	This Interface is the main menu of the application. It consists of three buttons which are start, setting, and credit button.		When users select the setting button, it will navigate to the setting to control music and sound effect.
	The users can select the virtual object (Book) and it will navigate users to education module, and the virtual object (Tv) will navigate users to Interactive Cooking Simulation.		This is the education module, the interface shows the information of dishes from Malaysia, Thailand, and Indonesia.
	This is the cooking simulation module; users need to select the country before starting to cook the dishes from the country itself.		After the users select the country, users need to select the dishes and it continue to cooking process.

3.4 Iterative Design Phase

The Iterative Design phase is a critical step in the TRES-D methodology, ensuring that the application evolves through continuous refinement. This phase is divided into two key sub-phases abstract Design and Presentation Design.

3.4.1 Abstract Design

Focuses on the logical architecture of the application. It involves designing how different components of the system interact, including the educational modules, VR environment, and cultural storytelling elements. Abstract design contains system flowcharts and navigation structures. The system flowchart as shown in **Appendix B** shows data, processes, and interactions within an application. Figure 3 represents the navigation structures that outline the user's path within the program.

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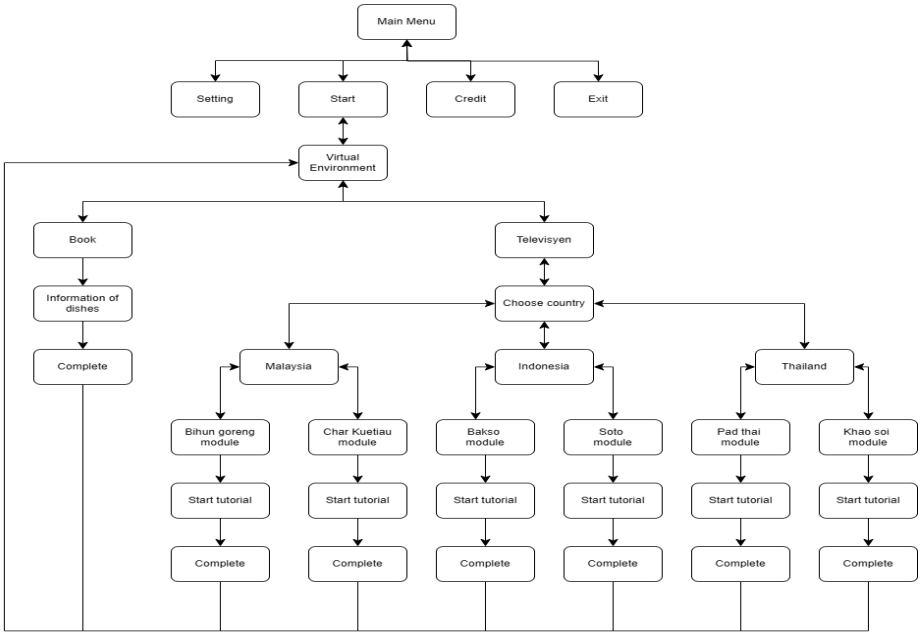

Fig. 3 *Navigation Structure*

3.4.2 Presentation Design

Centers on the user interface (UI) and user interaction (UX) aspects. Activities include creating prototypes of the application's UI, defining navigation paths, and testing usability with mockups. User Interface Prototypes, demonstrating the look and feel of the application.

Table 9 *Task details in Presentation Design*

Tasks	Details
Selecting Interaction Styles	Using input devices to interact with virtual objects, mimicking the preparation of noodles cooking
Basic Interaction Tasks	Users can interact with objects by using device controller to perform specific tasks.
Concrete Interaction Techniques	Device controllers is used in the application to enable users to interact with objects in the virtual world.
Design of World Structure	A virtual kitchen with local cooking ingredients can be designed to showcase the process of cooking "Mi Goreng".
Geometry and Appearance	Local elements like "Mi kuning" (a local Malaysian food), require detailed design of their geometry to render them in the application.
Reference from Real-World Models	Reference material can be gathered from real-world models, ensuring that the virtual version is as authentic as the actual food, such as "bawang merah".

Table 10 *Button design*

Button	Description	Button	Description
	• This is a start button. • It will bring user to 3D virtual environment.		• This is a next button. • It will bring user to next dishes in culinary education module.
	• This is a setting button. • It will bring user to setting interface.		• This is close button. • It will bring user to the 3D virtual environment.
	• This is a credit button. • It will bring user to credit interface.		• This is back button • It will bring user to interface before.

Table 10: *Button design (Cont.)*

Button	Description		
	• This is a applied button. • It will save the users changes in setting interface.		• This is a exit button. • It will exit the application.
	• This is a volume icon. • It will indicate the sound effect in the application.		• This is a music icon. • It will indicate the background music in the application.

3.5 Building and Implementation Phase

The focus shifts to actual development. Activities include writing code, integrating various application components, and conducting unit and integration testing. Developers work closely with designers and content creators to ensure that the virtual environment, storytelling elements, and cooking simulations are seamlessly implemented. This phase emphasizes iterative testing and debugging to deliver a functional product. A Fully Functional Application Prototype ready for evaluation and fine-tuning. Table 11 explained the integration of function in unity.

Table 11 *Integration in Unity*

Function	C# Script	Decsription
Cooking logic with ingredient tracking	`public class MiGorengCooker : MonoBehaviour { public List<string> requiredTags = new List<string> { "Bawang_putih", "Bawang_merah", "cili_kisar", "Isi_ayam", "sos_tiram", "sos_cili", "sos_tiram", "garam", "gula", "bihun", "tomato" }; private HashSet<string> addedIngredients = new HashSet<string>(); public GameObject bihunGorengPrefab; // Final cooked bihun model public Transform spawnPoint; // Where to place the cooked model public float cookDelay = 3f; // Time to wait before showing final model private bool isCooking = false; [Header("Collider Settings")] public Collider triggerCollider; // Assignable collider in the Inspector void Start() { if (triggerCollider != null) { triggerCollider.isTrigger = true; } else { }`	Checks for required tagged ingredients added via collider trigger. When all are present, waits a delay then spawns a cooked bihun prefab at a designated location.

Table 11: *Integration in Unity (Cont.)*

Function	C# Script	Decsription

Ingredient trigger detection	`public class ObjectCollisionTrigger : MonoBehaviour`
	`{`
	`  [Tooltip("The target object to trigger the event on collision.")]`
	`  public GameObject targetObject;`
	
	`  [Tooltip("The event to trigger when the objects collide or enter trigger.")]`
	`  public UnityEvent onCollisionEvent;`
	
	`  private void OnCollisionEnter(Collision collision)`
	`  {`
	`  // Check if the colliding object is the specified target`
	`  if (collision.gameObject == targetObject)`
	`  {`
	`  // Trigger the assigned event`
	`  onCollisionEvent.Invoke();`
	`  }`
	`  }`
	
	`  private void OnTriggerEnter(Collider other)`
	`  {`
	`  // For trigger-based detection`
	`  if (other.gameObject == targetObject)`
	`  {`
	`  onCollisionEvent.Invoke();`
	`  }`
	`  }`
	`}`
		Detects collisions or trigger events with specific objects and invokes UnityEvents (e.g., used for starting an animation or sound).

Volume control	`public class SoundManager : MonoBehaviour`
	`{`
	`  [SerializeField] Slider volumeSlider;`
	
	`  // Start is called before the first frame update`
	`  void Start()`
	`  {`
	`  if (!PlayerPrefs.HasKey("musicVolume"))`
	`  {`
	
	`PlayerPrefs.SetFloat("musicVolume", 1);`
	`  Load();`
	`  }`
	`  Else {`
	`  Load();`
	`  }`
	`  }`
	
	`  public void ChangeVolume()`
	`  {`
	`  AudioListener.volume = volumeSlider.value;`
	`  Save();`
	`  }`
	`  private void Load()`
		Controls global audio volume using a UI slider. Saves and loads volume preferences with PlayerPrefs.

Table 11: *Integration in Unity (Cont.)*

Function	C# Script	Decsription

	volumeSlider.value = PlayerPrefs.GetFloat("musicVolume");
	}
	
	private void Save()
	{
	
	PlayerPrefs.SetFloat("musicVolume", volumeSlider.value);
	}
	}	

Steam effect on ingredient contact	public class SteamTrigger : MonoBehaviour
	{
	public GameObject steamPrefab; // Assign your ParticleSystem prefab here
	public Transform spawnPoint; // Optional: where steam should appear (e.g., center of wok)
	private bool hasSteamed = false;
	
	private void OnTriggerEnter(Collider other)
	{
	if (!hasSteamed && other.CompareTag("Bawang_merah"))
	{
	Instantiate(steamPrefab, spawnPoint ? spawnPoint.position : transform.position, Quaternion.identity);
	hasSteamed = true; }
	}
	
	private void OnTriggerExit(Collider other)
	{
	if (other.CompareTag("Bawang_merah"))
	{
	hasSteamed = false; }
	}
	}
		Spawns a steam effect (e.g., particle system) when Bawang_merah enters a trigger zone, simulating cooking steam.

Stove fire level control via VR knob	public class VRStoveKnobClickCycle : MonoBehaviour
	{
	public GameObject fireLow;
	public GameObject fireMedium;
	public GameObject fireHigh;
	
	public XRGrabInteractable grabInteractable;
	
	private enum FireLevel { Off, Low, Medium, High }
	private FireLevel currentLevel = FireLevel.Off;
	
	// Snap angles: match FireLevel enum order
	private readonly float[] snapAngles = { 90f, 120f, 150f, 180f };
	
	void Awake(){
	if (grabInteractable == null)
	grabInteractable =
		Simulates a rotating stove knob using XR grab interaction. Cycles between Off, Low, Medium, and High fire levels, updating visual flame objects accordingly.

Table 11: *Integration in Unity (Cont.)*

Function	C# Script	Decsription

	`GetComponent<XRGrabInteractable>();`
	`}`
	
	`void Start()`
	`{`
	`currentLevel = FireLevel.Off;`
	
	`SetRotationToLevel(currentLevel); // Ensures it snaps to 90° at start`
	`UpdateFireVisual();`
	`}`	

Scene transition handler	`public class SceneController : MonoBehaviour`
	`{`
	`public void ChangeScene(string sceneName)`
	`{`
	
	`SceneManager.LoadScene(sceneName);`
	`}`
	`}`
		Loads a different Unity scene based on the given scene name string. Typically called by UI buttons or event triggers.

Furthermore, C# scripts are built to allow the application's core functionality. For example, Cooking logic with ingredient tracking, Ingredient trigger detection, Volume control, Steam effect on ingredient contact, Stove fire level control via VR knob, and Scene transition handler.

3.6 Deploy and Maintenance Phase

In this final phase, the application is released to users. Feedback mechanisms are implemented to collect user experiences, which guide updates and bug fixes. In this phase, functional testing and user acceptance testing is performed to identified bugs or error. Then, the developers will update the function to counter the bug error.

Table 12 *Functionality Testing*

Test	Expected Result	Actual Result	Corrective Action
Start Button	Start exploring the virtual kitchen.	Works well as expected	Not needed
Setting Button	Navigate to the setting panel		
Credit Button	Navigate to credit panel		
Next Button	Navigate to the next information panel for dishes information module.		
XR grab interaction	Grab all the object in the scene without glitches		
XR release interaction	Released an object and fall naturally due to gravity		
Audio	Play audio		
Ensure the box collider prevents the user from passing through objects.	Users can not go through the object because there is collision on the object.		
Detects collisions or trigger events with specific objects and invokes UnityEvents	A collider will detect collision from an object, and it will activate the other object.		
Activate a particle system (steam) effect on ingredient contact.	Spawns a steam effect when object enters a trigger zone, simulating cooking steam.		
Stove knobs click cycle	The off fire, low fire, medium fire, and high fire is in the correct position.	the position of knob when off is different, it not started in the desire position.	Set the position of off fire in script correctly.

Table 12: *Functionality Testing (Cont.)*

Test	Expected Result	Actual Result	Corrective Action
Trigger particle system to accumulate.	The particle system (fire) must collide with the wok and not to go through.	The particle system (fire) goes through the wok.	Add box collider to the wok and attach it into the collides properties in particle system inspector.

Table 12 shows functional testing results, which include corrective methods to improve VR performance and user experience. Section 4 will focus on user acceptability testing.

4. Result and Discussion

A User Acceptance Test was conducted with the target user to assess the effectiveness and satisfaction of the built system. These users were chosen because they matched the system's target demographic. They were given instructions to use the application to complete a variety of activities, such as navigation, feature utilization, and achieving specified system goals. Participants were then asked to fill out a System Usability Scale (SUS) questionnaire to give structured feedback on their experience.

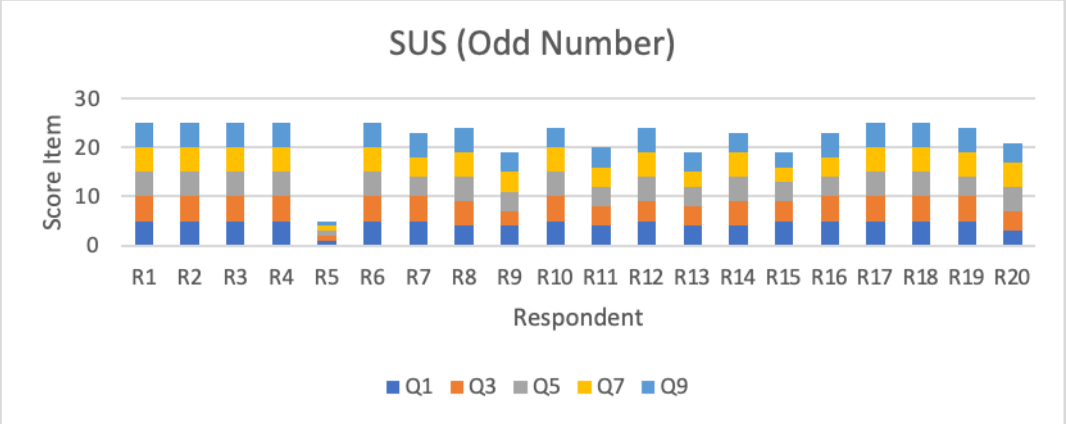

Fig. 4 *System Usability Scale Output(Odd Number)*

Question 1:	I think that I would like to use this VR application frequently
Question 3:	I thought the application was easy to use.
Question 5:	I found the various functions in this VR application were well integrated
Question 7:	I would imagine that most people would learn to use this VR application very quickly
Question 9:	I felt very confident using the VR application

Fig. 5 *System Usability Scale (Odd Number)*

Based on **figure 4**, the result for positive statement for questionnaire show that most respondents selected agree and strongly agree. It shows that the VR application is easy to use and acceptable.

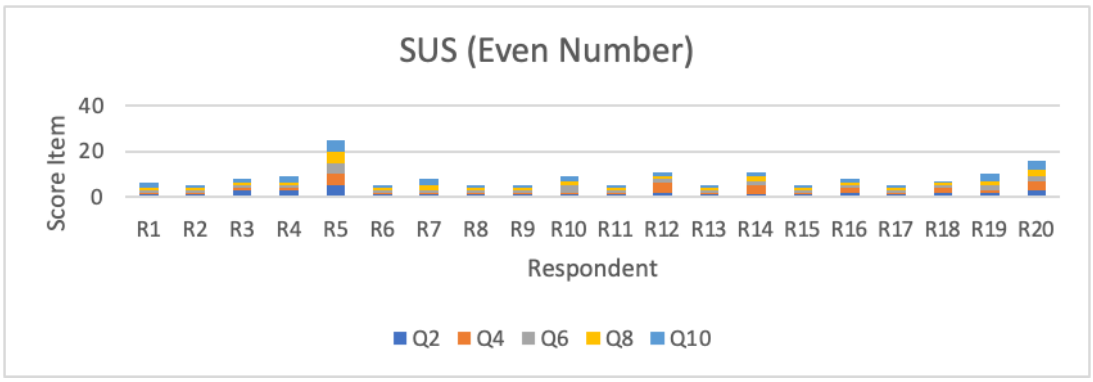

Fig. 6 *System Usability Scale Output (Even Number)*

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Question 2:	I found the application unnecessarily complex.
Question 4:	I think that I would need assistance to use the VR application.
Question 6:	I thought there was too much inconsistency in this application
Question 8:	I found the application very cumbersome to play.
Question 10:	I needed to learn a lot of things before I could get going with this application.

Fig. 7 *System Usability Scale (Even Number)*

Based on figure 6, the result for negative statement in the questionnaire show that most respondents selected disagree and strongly disagree. It shows that users are not experiencing any big issues with the VR application.

Table 13 *Respondent's Score*

Respondent	Item Score										Odd Score	Even Score	Total Score
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10			
R01	5	1	5	1	5	1	5	1	5	2	20	19	97.5
R02	5	1	5	1	5	1	5	1	5	1	20	20	100
R03	5	3	5	1	5	1	5	1	5	2	20	17	92.5
R04	5	3	5	1	5	1	5	1	5	3	20	16	90
R05	1	5	1	5	1	5	1	5	1	5	0	0	0
R06	5	1	5	1	5	1	5	1	5	1	20	20	100
R07	5	1	5	1	4	1	4	2	5	3	18	17	87.5
R08	4	1	5	1	5	1	5	1	5	1	19	20	97.5
R09	4	1	3	1	4	1	4	1	4	1	14	20	85
R10	5	1	5	1	5	3	5	2	4	2	19	16	87.5
R11	4	1	4	1	4	1	4	1	4	1	15	20	87.5
R12	5	2	4	4	5	2	5	1	5	2	19	14	82.5
R13	4	1	4	1	4	1	3	1	4	1	14	20	85
R14	4	1	5	4	5	2	5	2	4	2	18	14	80
R15	5	1	4	1	4	1	3	1	3	1	14	20	85
R16	5	2	5	2	4	1	4	1	5	2	18	17	87.5
R17	5	1	5	1	5	1	5	1	5	1	20	20	100
R18	5	2	5	2	5	1	5	1	5	1	20	18	95
R19	5	2	5	1	4	2	5	2	5	3	19	15	85
R20	3	3	4	4	5	2	5	3	4	4	16	9	62.5
											Average Score		84.38

Table shows the analysis of respondent's score from the questionnaire (Google Form). The formula used to obtain usability results based on the SUS:

Total score = (odd items + even items) x 2.5
Average score = Total score / Total Respondents
Where: Odd Items (Q1, Q3, Q5, Q7, Q9) = Contribution – 5
Even Items (Q2, Q4, Q6, Q8, Q10) = Contribution – 1
Therefore, average score = (97.5 + 100 + 92.5 + 90 + 0 + 100 + 87.5 + 97.5 + 85 + 87.5 + 87.5 + 82.5 + 85 + 80 + 85 + 87.5 + 100 + 95 + 85 + 62.5) / 20
= 84.38

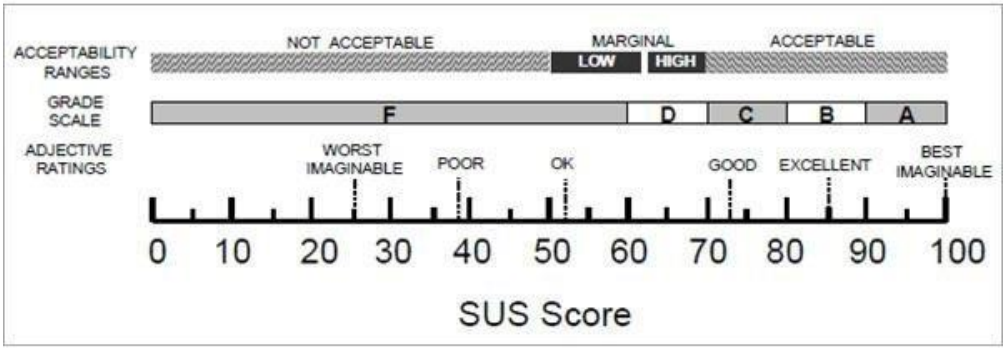

Fig. 9 *System Usability Scale (SUS)* [13]

The average score for each question from the user testing is 84.38, it is "Acceptable", grad scale is in "B", and it shows "Excellent" in adjective ratings. All things considered; the integrated application successfully meets the demands of the intended users.

5. Conclusion

Noodles VR application enhances users' knowledge about Southeast Asia dishes, according to testing data. On top of that, the project's three objectives were successfully met by designing VR application that simulates the preparation of noodle dishes, succeeded in developing Noodles VR by using virtual reality technology, and lastly executing the user acceptability and functional testing following the completion of the development process.

The Noodles VR application offers several significant benefits. It offers a number of interactive features and well-integrated functionalities. The application also offers constant functioning and a steady, predictable user experience and engages youth in local culture. It also useful for users who cannot attend physical culinary classes.

Nevertheless, the program possesses specific limitations. Presently, the application just includes one noodle dishes in cooking simulation module from every country. Next, users cannot customize their meals according to the desired quantity in the application and it limited with database of recipes. Lastly, It is not accessible to users without compatible VR hardware.

Furthermore, Table 15 lists the advantages and limitations of the Noodles VR application. Lastly, adding more country that are in Southeast Asia into the application is advised for future development. Also, more noodle dishes for cooking simulation module might be added to each country.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design**: Amirul Hariz Nor Azman, Mohd Farhan Md. Fudzee; data collection: Amirul Hariz Nor Azman; **analysis and interpretation of results**: Amirul Hariz Nor Azman, Mohd Farhan Md. Fudzee; **draft manuscript preparation**: Amirul Hariz Nor Azman, Mohd Farhan Md. Fudzee. All authors reviewed the results and approved the final version of the manuscript

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Appendix A: Interview transcribes with SME

Amirul Hariz:	Good morning, Sir Afif. Thank you for taking the time to meet with me today. I understand you have 3 years of experience teaching at FPTV in UTHM. Your insights will be invaluable for my project on a VR-based application for preparing noodle dishes from Malaysia, Indonesia, and Thailand.
Sir Afif:	Good morning! I'm happy to help. This sounds like an exciting project, and I'm glad to contribute to your research and development.
Amirul Hariz:	To start, could you share your perspective on the educational potential of VR applications, particularly for cultural and culinary learning?
Sir Afif:	Certainly. VR has tremendous potential to make learning more immersive and engaging. In the context of cultural and culinary education, VR allows users to experience and explore traditions and techniques in a way that textbooks or videos cannot. For example, it can simulate the hands-on process of preparing food while also providing a cultural backdrop that enhances the learning experience.
Amirul Hariz:	My project specifically focuses on simulating the preparation of Southeast Asian noodle dishes, including dishes like Malaysia's Bihun goreng, Indonesia's Bakso, and Thailand's pad Thai How do you think these dishes can represent the region's culture in my VR application?
Sir Afif:	These dishes are excellent choices because they are iconic and reflect the diversity of Southeast Asian cuisines. Each dish tells a significance story.
Amirul Hariz:	That's a good point. From a cultural perspective, how can I ensure that these dishes are presented authentically in the simulation?
Sir Afif:	Authenticity comes from the details. For example, you need to make sure that the simulation includes culturally accurate ingredients like sweet soy sauce for Bihun goreng, tamarind for Pad thai, and meatballs for Bakso.
Amirul Hariz:	I also plan to include a "Cultural Education Module" alongside the cooking simulation. How can I make this module engaging while teaching users about the dishes?
Sir Afif:	You can make it engaging by Add short clips of noodle-making techniques or traditional markets where these dishes are commonly sold.
Amirul Hariz:	From your teaching experience, what challenges might learners face in understanding the complexity of these dishes, and how can I address these in the VR application?
Sir Afif:	The main challenges could be users might not know what certain ingredients look like. Use high-quality 3D models and labels for each ingredient. Also, Techniques like stir-frying or grinding spices might be intimidating. Provide a tutorial or practice mode to help users learn.

Amirul Hariz:	Lastly, do you have any advice on how I can validate the recipes and ensure they are culturally accurate?
Sir Afif:	Validation is crucial. You can take the recipe from Reference reputable cookbooks or culinary websites. Also, Test the application with users from diverse cultural backgrounds to get feedback on the authenticity.
Amirul Hariz:	Thank you, Sir Afif. This discussion has been very enlightening and will greatly help in refining my project.
Sir Afif:	You're welcome. I'm glad to help. I look forward to seeing the final product. Best of luck with your project!

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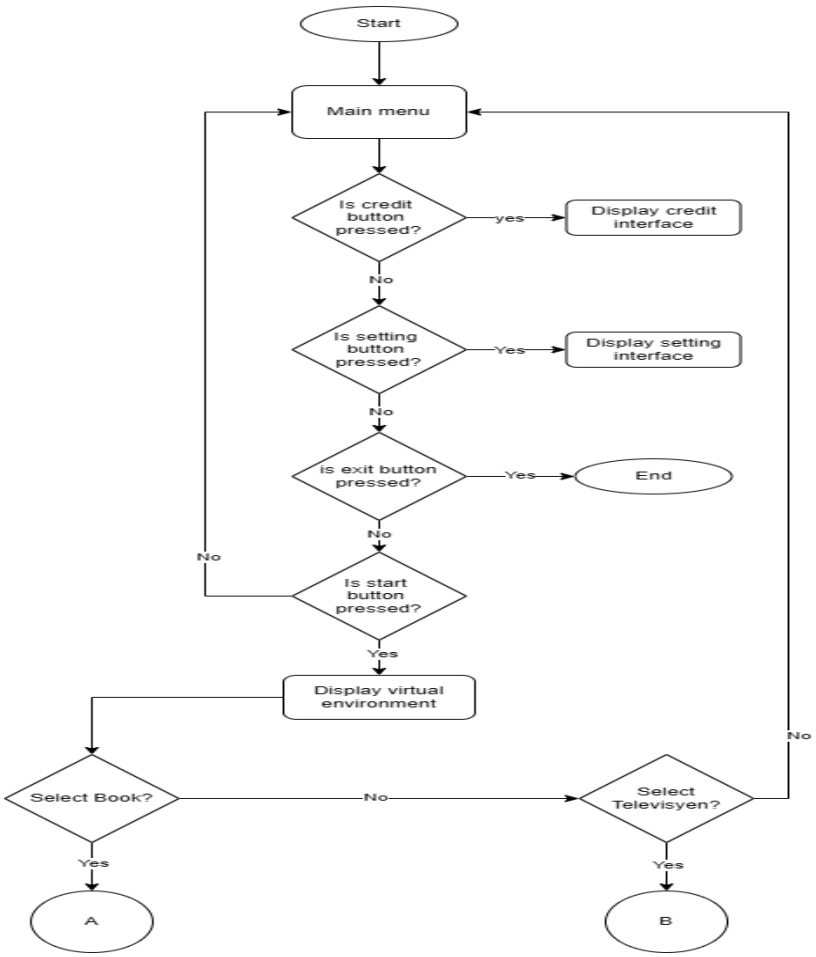
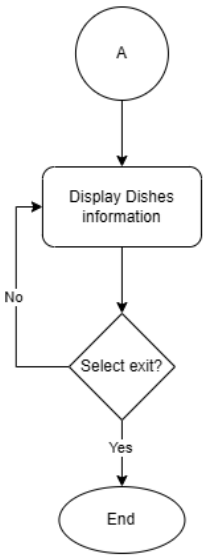
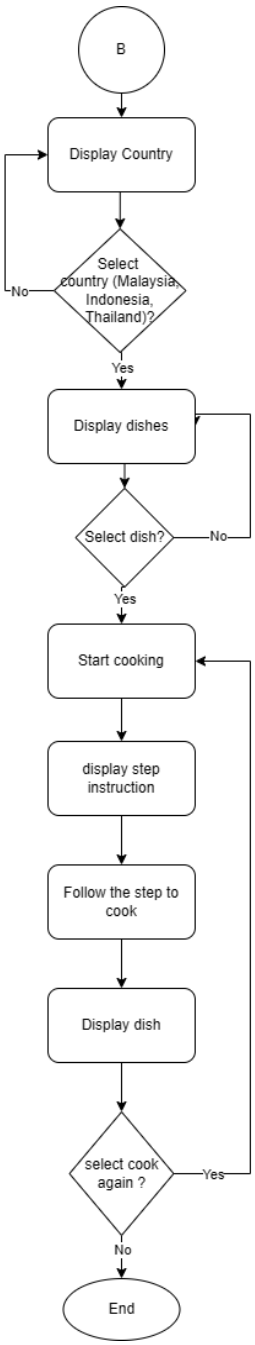
Appendix B: System Flowchart




A
Display Dishes information
No
Select exit?
Yes
End


B
Display Country
Select country (Malaysia, Indonesia, Thailand)?
No
Yes
Display dishes
Select dish?
No
Yes
Start cooking
display step instruction
Follow the step to cook
Display dish
select cook again ?
Yes
No
End