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3D Application Development with Blender and Roblox Integration: A Case Study of the North Sumatera State Museum

Maulana Malik Fajri[1]*, Said Iskandar Al Idrus[2], Yulita Molliq Rangkuti[3], Kana Saputra S[4], Debi Yandra Niska[5]

[1,2,3,4,5]Ilmu Komputer, Universitas Negeri Medan
malikfajrim@gmail.com[1*]

Abstract

This research explores the potential of Metaverse and Immersive Space technologies to enhance virtual tourism experiences at the North Sumatra State Museum through the integration of Blender and Roblox Studio. The main focus is on developing complex and interactive metaverse content, as well as implementing an adaptive visit counting system. The methodology involves developing a 3D application using Blender for modeling and Roblox Studio for the virtual environment. Key results include the addition of Virtual Reality (VR) features, expansion of the virtual museum collection, and a continuous evaluation system based on user feedback. In conclusion, the integration of Blender and Roblox Studio proves effective in creating immersive virtual museum experiences, opening new opportunities in utilizing Metaverse technology to increase museum accessibility and offering innovative solutions for preserving and promoting cultural heritage through digital platforms.

Keywords: *Blender, Digital Cultural Heritage, Immersive Space, Roblox Studio, Virtual Museum*

1. Introduction

The North Sumatra State Museum in Medan is a cultural preservation institution established in 1954, housing more than 6,000 artifacts spanning various categories such as archaeology, ethnography, ceramics, and numismatics. However, low public interest, particularly among the younger generation, in visiting museums poses a significant challenge. Despite efforts such as school visits, many people remain unaware of the importance of museums as centers for education and cultural conservation [1], [2]. This highlights the need for a more engaging approach to increase visitor interest, particularly through technology-driven innovations.

The advancement of information and communication technology offers significant opportunities through the Metaverse concept, enabling virtual experiences based on 3D objects [3]. Roblox, as one of the leading Metaverse platforms, provides immersive virtual spaces that support the creation of interactive worlds tailored to user needs. With features such as virtual identity, digital economy, and diverse content, Roblox can serve as an effective medium to support the concept of Metaverse Tourism [4], [5]. Advanced technologies like 360° video mapping and immersive displays enable the simulation of real-world environments interactively, enhancing cultural understanding visually and educationally [6], [7].

Previous studies have demonstrated the substantial potential of Metaverse technology for virtual tourism, including the development of tourist destinations through Roblox Studio applications. For instance, the virtualization of destinations in Berastagi using Roblox has positively influenced destination image and visitor interest [8], [9]. In the context of the North Sumatra State Museum, leveraging platforms like Roblox to create engaging and immersive virtual tourism experiences can be an innovative solution to enhance the museum's appeal, bridge the gap between the younger generation and local cultural heritage, and strengthen the museum's image in the digital era [10], [11].

2. Research Method

This research employs a Research and Development (R&D) approach to develop a desktop application that allows users to explore tourist attractions virtually. The primary focus of this study is to enhance user engagement and experience in exploring tourist destinations. The research stages include observation, design, implementation and integration, publication, and usability testing, as illustrated in Figure 1.

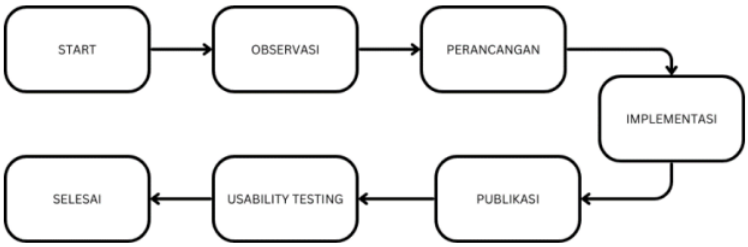


Fig. 1: Research workflow

2.1. Observation

The researcher will visit the North Sumatra State Museum to observe its architecture, layout, ornaments, and other elements within the museum, as well as its surrounding environment, such as gardens and supporting buildings. Data will be collected through note-taking, photographs/videos, and interviews with guides or museum management.

2.2. Design

Based on the observations, the researcher will design the Metaverse Tourism concept for the museum. This includes determining virtual destinations, visual design, storyline, and interactive features to be showcased, such as storyboards, design sketches, and selecting supporting elements.

2.3. Implementation

The researcher will create 3D models using Blender and develop these models in Roblox Studio, including modeling the museum building, ornaments, and surrounding elements. This process involves modeling, texturing, lighting, and developing program codes using the LUA programming language. The completed 3D models will be imported into Roblox Studio with proper formatting, sizing, and positioning to ensure compatibility and high-quality rendering.

2.4. Publication

Once development is complete, the virtual environment will be published on the Roblox platform for user access. This process includes configuration, testing, and optimization for various devices.

2.5. Usability Testing

The researcher will distribute questionnaires to users who experience the virtual environment to evaluate ease of use, visual quality, educational value, and overall user experience.

3. Result and Discussion

3.1. Observation Results

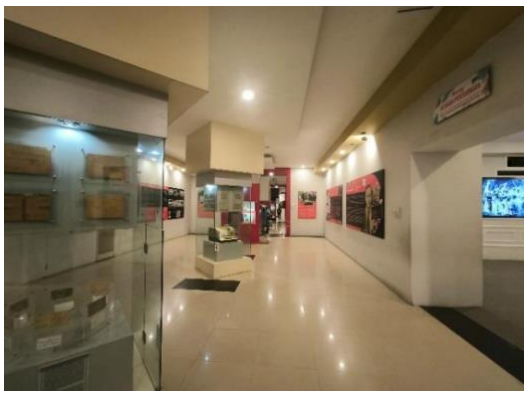
The North Sumatra State Museum, located in the heart of Medan on Jalan H.M. Joni No. 51, was established in 1982 and spans an area of 10,468 m². The museum serves as a center for the conservation of North Sumatra's cultural and historical heritage, housing a collection of artifacts and artworks that reflect the region's ethnic diversity. The museum building features two floors with thematic exhibition rooms, incorporating architectural designs that blend traditional Batak elements with modern styles. The museum's façade is adorned with distinctive Batak carvings, adding cultural and aesthetic value.

The museum's layout is divided into four main zones, as depicted in the following figure:

(a) Prehistoric room

(b) Nusantara zone

(c) Ethnography zone



(d) Colonial and struggle zone

Fig. 2: Museum zones

Additionally, the museum features several unique ornaments and key elements, shown in the following figure:

(a) Ulos

(b) Traditional house replica

(c) Statues and reliefs

Fig. 3: Ornaments and key elements

The surrounding environment also includes supporting facilities, as illustrated in the following figure:

(a) Taman

(b) Area Parkir

(c) Perpustakaan

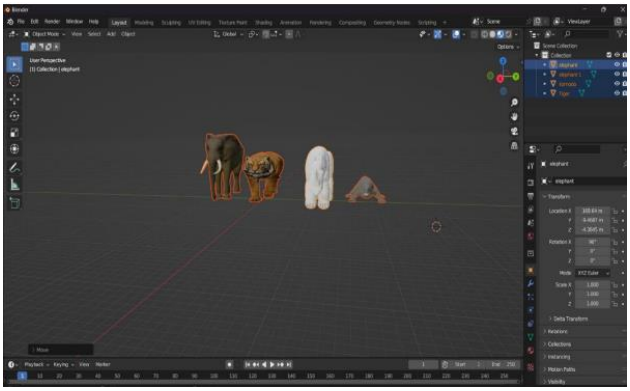
Fig. 4: Museum surroundings

3.2. Application Design

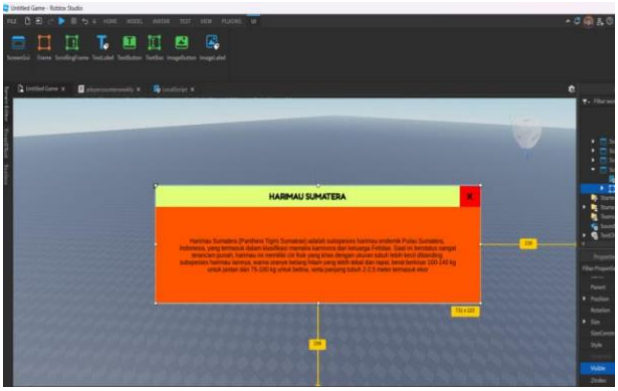
During the content design stage, 3D objects for the virtual museum were created using Blender software. Detailed models of fauna, such as elephants, tigers, rhinoceroses, and Komodo dragons, were developed and prepared for user interaction in Roblox Studio. Each model was placed in a separate scene to facilitate easier editing and configuration, with particular attention to realistic scaling, proportions, and lighting. The aim of this design was to create visually appealing and educational representations of fauna for visitors.

For descriptive interface design, elements such as buttons, panels, and text were added through screengui in Roblox Studio. A frame object served as the main container, featuring prominent content titles and interactive information, such as descriptions of the "Sumatran Tiger." The interface was designed to be easy to read, with text formatting optimized for visitor convenience.

In the Player Count interface, a light green frame was displayed at the top center of the screen to show player count information for the day, week, and month. This visual design was chosen for readability and contrast against the background. The final design stage involved creating a 3D model of the museum building, referencing photos or videos from the site survey to ensure accuracy of the building's original form.

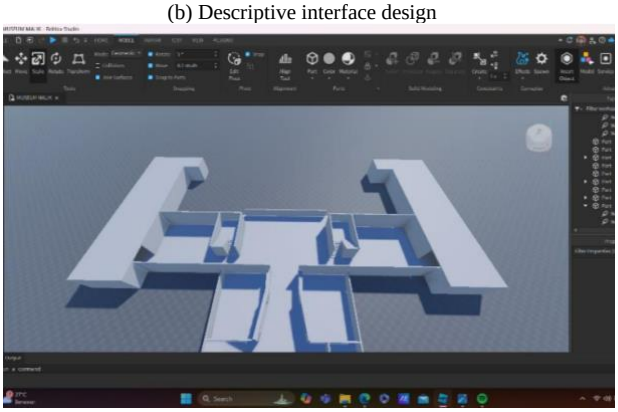


(a) Content design



(b) Descriptive interface design

(c) Player count interface design



(d) Museum design

Fig. 5: Application design

3.3. Implementation

At this stage, the implementation of algorithms began with adding asset scripts to objects in Roblox Studio. Scripts for the North Sumatra State Museum were created to support game functionality. Below is the code used during the game development. The scripts included functionality for real-time player count display (Player Count), client-server communication using Remote Event, interactive and descriptive interface settings, and door animation control with Proximity Prompt. Each script was designed to enhance user interaction and provide a more immersive gaming experience.

```lua
local Players = game:GetService("Players")
local DataStoreService = game:GetService("DataStoreService")
local ReplicatedStorage = game:GetService("ReplicatedStorage")

-- Create RemoteEvents if they don't exist
local playerCountEvent = Instance.new("RemoteEvent")
playerCountEvent.Name = "PlayerCountEvent"
playerCountEvent.Parent = ReplicatedStorage

local weeklyTotalEvent = Instance.new("RemoteEvent")
weeklyTotalEvent.Name = "WeeklyTotalEvent"
weeklyTotalEvent.Parent = ReplicatedStorage

local currentDayEvent = Instance.new("RemoteEvent")
currentDayEvent.Name = "CurrentDayEvent"
currentDayEvent.Parent = ReplicatedStorage

local monthlyTotalEvent = Instance.new("RemoteEvent")
monthlyTotalEvent.Name = "MonthlyTotalEvent"
monthlyTotalEvent.Parent = ReplicatedStorage

-- Initialize variables
local totalCount = 0
local weeklyTotal = 0
local monthlyTotal = 0
local currentDay = 1

-- DataStore setup
local playerCountStore = DataStoreService:GetDataStore("PlayerCountStore")

local function
    local currentTime = os.time()
    local currentDate = os.date("*t", currentTime)
    return currentDate.hour == 0 and currentDate.min == 0
```

(a) Server script code for player count

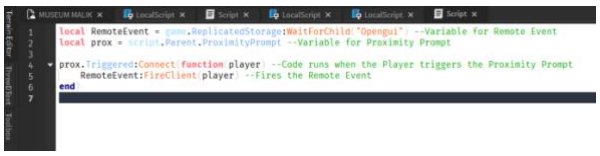
```lua
local ReplicatedStorage = game:GetService("ReplicatedStorage")

local playerCountEvent = ReplicatedStorage:WaitForChild("PlayerCountEvent")
local weeklyTotalEvent = ReplicatedStorage:WaitForChild("WeeklyTotalEvent")
local currentDayEvent = ReplicatedStorage:WaitForChild("CurrentDayEvent")
local monthlyTotalEvent = ReplicatedStorage:WaitForChild("MonthlyTotalEvent") -- Tambahan event untuk monthly

local playerGui = script.Parent
local frame = playerGui:WaitForChild("Frame")
local dailyTotalLabel = frame:WaitForChild("DailyTotalLabel")
local weeklyTotalLabel = frame:WaitForChild("WeeklyTotalLabel")
local currentDayLabel = frame:WaitForChild("CurrentDayLabel")
local monthlyTotalLabel = frame:WaitForChild("MonthlyTotalLabel") -- Tambahan label untuk monthly

local function
    dailyTotalLabel.Text = "Total Hari Ini: " .. totalCount
end

local function
    weeklyTotalLabel.Text = "Total Minggu Ini: " .. weeklyTotal
end

local function
    currentDayLabel.Text = "Hari ke-" .. currentDay
end

local function
    monthlyTotalLabel.Text = "Total Bulan Ini: " .. monthlyTotal
end

playerCountEvent.OnClientEvent:Connect(updateDailyTotal)
weeklyTotalEvent.OnClientEvent:Connect(updateWeeklyTotal)
currentDayEvent.OnClientEvent:Connect(updateCurrentDay)
monthlyTotalEvent.OnClientEvent:Connect(updateMonthlyTotal) -- Koneksi event monthly
```

(b) Player count code

```lua
local RemoteEvent = game.ReplicatedStorage:WaitForChild("Opengui")
local closeButton = script.Parent.Tiger.Close -- Assuming you have a CloseButton inside the Sho

local guiVisible = false -- Variable to track the GUI's visibility

closeButton.MouseButton1Click:Connect(function()
    script.Parent.Tiger.Visible = false
    guiVisible = false
end)

RemoteEvent.OnClientEvent:Connect(function()
    if guiVisible then
        script.Parent.Tiger.Visible = false
        guiVisible = false
    else
        script.Parent.Tiger.Visible = true
        guiVisible = true
    end
```

(c) Descriptive interface code

```lua
local TweenService = game:GetService("TweenService") -- smooth animation

local hinge = script.Parent.Hinge
local prompt = script.Parent.Door.ProximityPrompt

local goalOpen = {}
goalOpen.CFrame = hinge.CFrame * CFrame.Angles(0, math.rad(90), 0) --getting current hinge CFrame and multiplying it so that it rotates i

local goalClose = {}
goalClose.CFrame = hinge.CFrame * CFrame.Angles(0, 0, 0) --does the same thing but closes the door now

local tweenInfo = TweenInfo.new(1) --takes one second for the tween to open and close
local tweenOpen = TweenService:Create(hinge, tweenInfo, goalOpen) --we want to tween/rotate the hinge
local tweenClose = TweenService:Create(hinge, tweenInfo, goalClose)

prompt.Triggered:Connect(function()
    if prompt.ActionText == "Close" then
        tweenClose:Play()
        prompt.ActionText = "Open"
    else
        tweenOpen:Play()
        prompt.ActionText = "Close"
    end
end)
```



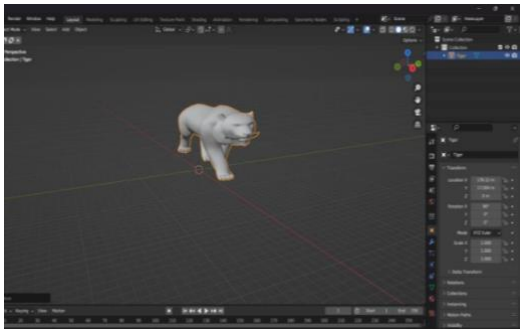
(d) Interface code

(e) Door code

Fig. 6: Program codes

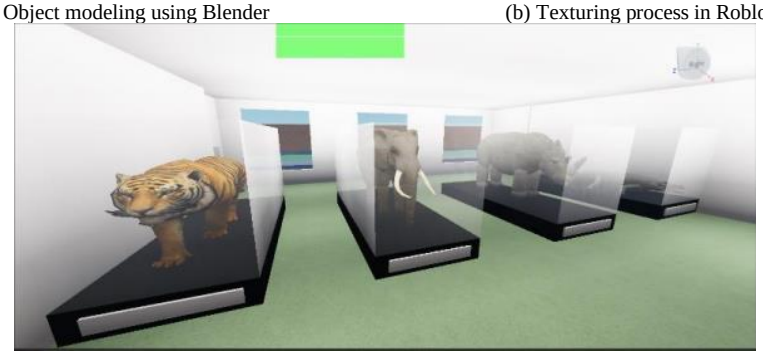
3.4. 3D Content Creation

The process of creating 3D objects for the North Sumatra State Museum began with meticulous planning, including determining poses, visual references, and desired design styles. Modeling was performed using Blender with techniques such as extrude, loop cut, and subdivision to create highly detailed objects. Once the base model was completed, texturing was done using UV mapping and texture creation in software like Photoshop or GIMP, including the use of normal maps for additional detail. The 3D models were then exported to Roblox Studio, optimized for performance, and integrated with Lua scripts for interactivity, ensuring proper functionality within the gaming environment.



(a) 3D Object modeling using Blender

(b) Texturing process in Roblox Studio



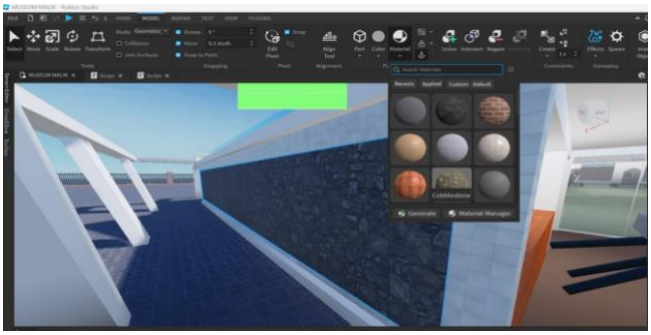
(c) Blender-to-Roblox Studio integration process

Fig. 7: 3D Content Creation

3.5. Museum Creation

Creating the museum object in Roblox Studio involved several stages, starting with building the 3D model using basic shapes and available tools. After the model was formed, detailing was done to refine the design, followed by adding textures for a more realistic appearance. To ensure players could navigate the museum without falling through surfaces, collider components were added as invisible barriers to prevent physical objects from penetrating the surfaces. Finally, interactive scripts were incorporated to add functionality to certain objects, enhancing the user experience within the virtual museum environment.

(a) 3D Object creation of the North Sumatra State Museum



(b) Texture creation in Roblox Studio

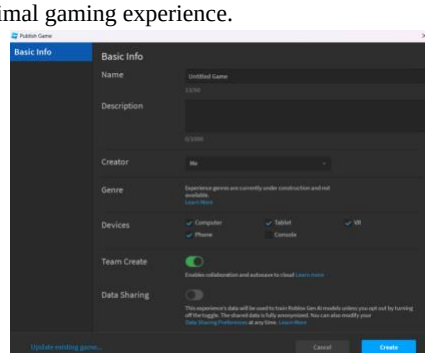
(c) Player interaction with Proximity Prompt example

Fig. 8: Museum creation

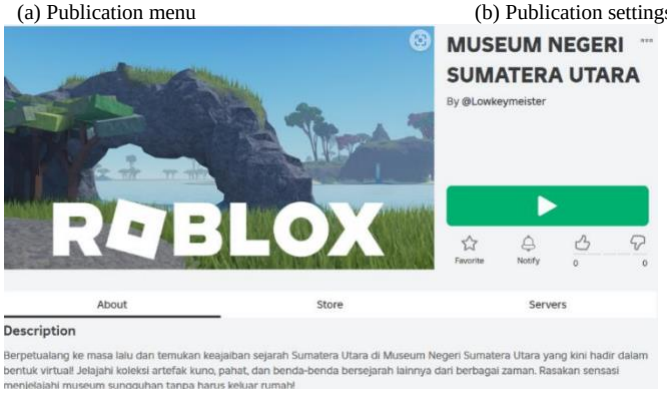
3.6. Publication and Post-Publication Testing

Pre-publication preparation involved comprehensive testing of features, performance, and visual consistency, as well as validating scripts and optimizing for improved performance and reduced lag. After testing, users could access the publication menu in Roblox Studio to select "Push to Roblox" or "Publish to Roblox As…" to update or create a new version of the game. The publication settings included configuring the title, description, category, privacy, and an attractive cover image. The publication process involved clicking the "Publish" button, monitoring the progress bar, and recording the unique game ID. After publication, post-publication testing was conducted by playing the game on various devices to ensure compatibility and an optimal gaming experience.

(a) Publication menu



(b) Publication settings



(c) Application homepage display after publication

Fig. 9: Publication and post-publication settings

3.7. Usability Testing

Table 1: Satisfaction score calculation

No	Statement	Total Score	Average
1	I find it easy to start the game	183	4.58
2	Navigation within the game is intuitive and not confusing	182	4.55
3	The game is enjoyable and engaging to play	179	4.48
4	The graphics and design enhance my gaming experience	179	4.48
5	The game runs smoothly without technical issues	178	4.45
6	The game's loading time is acceptable and not too long	176	4.40
7	The controls are responsive and easy to use	178	4.45
8	Social features in the game (e.g., chat) enhance my experience	179	4.48
9	It is easy to interact with other players in the game	178	4.45
10	The in-game explanations are clear and easy to understand	182	4.55
Overall Average		179.4	4.487

Table 2: Satisfaction score criteria

No	Score Range	Criterion
1	>= 4.5	Very High
2	4.0 – 4.5	High
3	3.5 – 4.0	Adequate
4	<= 3.5	Needs Improvement

The game received very positive feedback with an average score of 4.49 out of 5, indicating high satisfaction and consistency across all measured aspects. All aspects, including ease of starting the game (highest score of 4.58) and loading time (lowest score of 4.40), received scores above 4.40, reflecting an overall high quality. While the loading time scored the lowest, it still falls into the high category, demonstrating that the game successfully delivered a satisfying experience to players.

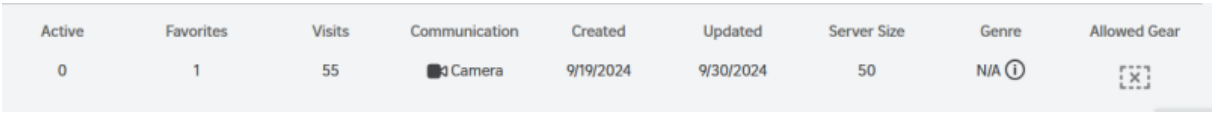


Fig. 10: Visitor count

Based on Figure 10, the average weekly visits amounted to 55, with an average daily visit rate of 7.86 (approximately 8) visits per day over a full week.

4. Conclusion

Based on the implementation and testing results of the Roblox-based virtual Museum Negeri Sumatera Utara application with Blender and Roblox Studio integration, it can be concluded that utilizing Metaverse technology and immersive spaces has successfully enhanced the virtual historical tourism experience with unrestricted access in terms of time and distance. The integration of Blender and Roblox Studio created an interactive virtual environment with detailed museum objects, providing an engaging and informative experience. Roblox proved to be an effective Metaverse platform with interactive features such as collection information, augmented reality, and multiplayer functionality. Additionally, the visitor count system was successfully implemented, enabling administrators to monitor and analyze virtual museum visitation levels effectively.

Acknowledgement

We extend our heartfelt gratitude to the North Sumatra State Museum for their invaluable support and collaboration throughout this project. Their willingness to provide access to the museum's facilities, collections, and cultural insights greatly contributed to the successful development of this virtual museum application. We are especially grateful to the museum staff for their guidance and assistance during on-site observations, enabling us to accurately represent the rich cultural heritage of North Sumatra in a digital format.

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