

Using Real-Time Ray Tracing in Game Action-Adventure ANGKARA "The Rise of Asura"

Putu Wirayudi Aditama^{1)*}, I Gede Adi Sudi Anggara²⁾, Jilmi Alparizi³⁾

^{1,2,3)}Pusat Studi Digitalisasi Budaya Bali (Institut Bisnis dan Teknologi Indonesia), Indonesia

¹⁾wirayudi.aditama@instiki.ac.id, ²⁾adi.sudianggara@instiki.ac.id, ³⁾jimialparizi@instiki.ac.id

Submitted : Jul 5, 2024 | **Accepted** : Jul 30, 2024 | **Published** : Jul 31, 2024

Abstract: The pressing problems facing the games industry in Indonesia are first, the lack of developers who can meet the needs of the local market and the lack of adaptation of local content in games. Second, how to improve the optimization of the Ray Tracing process? To overcome these challenges, this research aims to design and build an action-adventure game model using Unreal Engine 5. By developing the Real-Time Ray Tracing (RTRT) feature. The game design will also utilize the latest technology such as Ray Tracing, and artificial intelligence to create an immersive and realistic gaming experience. The method used in this research is GDLC (Game Development Life Cycle). The results of research using black box testing with components, character responsiveness, basic attacks, interaction with the environment, defense, enemy behavior, and optimization of Ray Tracing state that it has been validated.

Keywords: Indonesian Game Industry; Action-Adventure Game Model; Game Development; Ray Tracing.

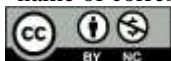
INTRODUCTION

The development of the gaming industry, especially in Indonesia, is currently experiencing growth and the number of gamers is increasing every year. Data obtained from Katadata.co.id in 2022 recorded that 94.5% of internet users aged 16-64 years in Indonesia played video games as of January 2022. The gaming industry is a fast-growing industry whose growth is predicted to continue in line with projections. income. amounting to 1.08 percent in 2024. Meanwhile, the level of mobile gaming users in Indonesia is estimated to reach 68.03 million people in the same year. The gaming industry in Indonesia is experiencing significant development and the growth of game developers is increasing every year. Data displayed in 2022 via the Indonesia Game (IGRS) platform notes that in 2022 there will be 350 Indonesian game developers consisting of 85 local developers and 265 foreign developers.

The urgency of this research is 1) The problem faced by the game industry and developers, especially in Indonesia, is the lack of game developers who can meet market needs in Indonesia, Indonesia is a very large game platform and market (Harahap & Ramadan, 2021) (Limianto, 2019). 2) The second problem is optimization of Ray Tracing. In this research, the author intends to optimize the Ray Tracing feature to improve lighting so that the game looks more realistic. This research will utilize Unreal Engine 5 as the main development platform. In the Action-Adventure game, applying visual effects that are pleasing to the eye can increase player immersion and provide a more satisfying playing experience (Gunawardhana & Palaniappan, 2016) (Allsop & Jesse, 2015). Angkara is an action-adventure game that combines elements of adventure, magic, and epic stories. Players will take on the role of "Arka", the main character who faces various challenges, takes revenge against his country which has been attacked and destroyed and uncovers the mystery behind Azura's attack.

The aim of designing this game model is to optimize the Ray Tracing feature and to test the application of the latest technologies in game development, physics processing and artificial intelligence

*name of corresponding author



This is anCreative Commons License This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

for NPCs (Non-Player Characters), thereby creating realistic and interesting challenges for players (Dhote et al., 2020; Wang et al., 2022). With this technology and the application of AI in it which allows "Enemies" to have intelligence in the form of detecting whereabouts, adjusting distance when fighting and avoiding attacks, it will add to the user's playing experience. To assess the educational and cultural potential that games have through the delivery of values or learning through gameplay offered to players.

LITERATURE REVIEW

This game has 3 levels with different levels of difficulty for each level. After being built and tested, it can be concluded that the game can provide a more enjoyable form of teaching and can even make students who play it interested in learning the history of the Banjar War. Based on the results of the usefulness questionnaire, 47% of respondents said they strongly agreed, 43% said they agreed. 10% said they disagreed and 0% said they strongly disagreed. So this game application can be used by the younger generation to attract interest in the history of the Banjar war (Fauzan et al., 2022). The next research was carried out entitled "Application of Finite State Machines for Animation Control in the RPG Nusantara Legacy Video Game". This research succeeded in implementing Finite State Machine in the game RPG Nusantara Legacy (MUSIRAWAS Lubuklinggau & Rahmawati, 2018). Finite State Machine is good enough to design animation controllers in RPG video games like this Video game. The next research carried out by the game "TANARA" was designed and created using Corel Draw software for design and Unity for programming (Rohmawati & Menarianti, 2019). The educational game application "TANARA" has met the criteria for validity and practicality, so it is suitable to be used as a media to help learn about Indonesian culture. entitled "Folklore Themed Game "The Red Riding Hood and the Wolf" with the Game Development Life Cycle Development Method" (Laksmi et al., 2023). Action-Adventure games are one of the most popular game genres in the world (8), developing Action-Adventure games is a complex process and requires a variety of skills and knowledge (Gintere et al., 2024) (Pasqualotto et al., 2023) (Ren et al., 2024), there are various factors that need to be considered in developing action-adventure games, including gameplay, story, and graphics (McIntosh et al., 2022), (Mulati, 2022), (Boros et al., 2023).

The novelty of the action-adventure game by implementing Unreal Engine 5 to design the game "Angkara: The Rise of Asuras", including 1) Lumen Lighting System This real-time lighting system ensures that in-game lighting looks natural and realistic without requiring pre-calculations, essential for building a rich and dynamic atmosphere. Real-time ray tracing (RTRT) enables the creation of interactive experiences with subtle lighting effects on par with many offline real-time renderers. Ray tracing effects look more natural, produce soft shadows for lights, accurate ambient occlusion (AO), and global lighting, interactive. 2) Animation and AI The animation and AI system in this game model allows the creation of characters that look lifelike and have realistic responses to players. DLSS is an abbreviation for Deep Learning Super Sampling, a technology that uses artificial intelligence (AI) to improve graphic quality and video game performance. DLSS works by reducing the resolution of the displayed image to a lower resolution, and then using AI to reconstruct the image to a higher resolution.

METHOD

In this research, the method used in this game model is GDLC (Game Development Life Cycle). This GDLC method involves several stages in the game development process: Initiation, Pre-Production, Testing, Beta, and Release. With the GDLC game development flow, developers can follow structured steps to create quality games.

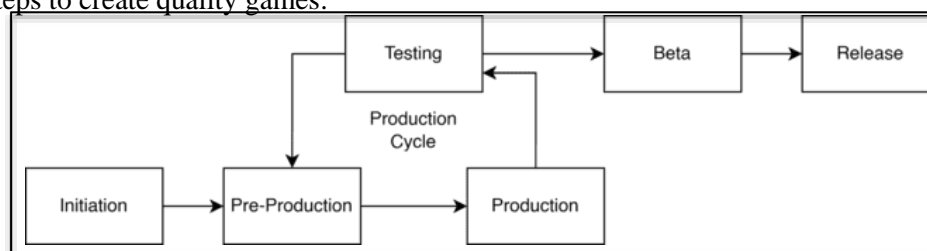


Fig. 1 Game Development Life Cycle

*name of corresponding author



This is anCreative Commons License This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

1. Initiation

The initiation stage is the initial step where the idea and concept of a game begin to be formed. During this stage, various important aspects of the game "Angkara: The Rise of Asuras" will be determined and detailed.

2. Pre-Production

The pre-production stage is the period where detailed planning of all aspects of the game is realized and compiled. At this stage, the main focus is to lay out a strong and clear foundation for further game development. All aspects of the game, from design to technical and artistic development, are carefully prepared to ensure the next stage of production can proceed as planned and with as little disruption as possible.

3. Production

The production stage is a period where the game is actively developed based on plans that have been prepared in the pre-production stage. The production stage is the main focal point in GDLC where concepts and designs begin to become reality. The development team works together to realize the game vision systematically, paying attention to quality, consistency, and conformity to previously prepared plans.

4. Testing

The testing phase is an important phase in the development of the game "Angkara: The Rise of Asuras." In this stage, various game elements and features will be tested to ensure quality, performance and reliability before being released to the market. This testing may include functional testing, performance testing, platform compatibility testing, safety testing, and beta testing with player participation. Elements such as game mechanics, graphics, storyline and character artificial intelligence will be tested in detail to ensure a smooth and enjoyable gaming experience for players.

As a medium for understanding the Gameplay system, the following is a Flowchart for the ANGKARA Game "The Rise of Asura".

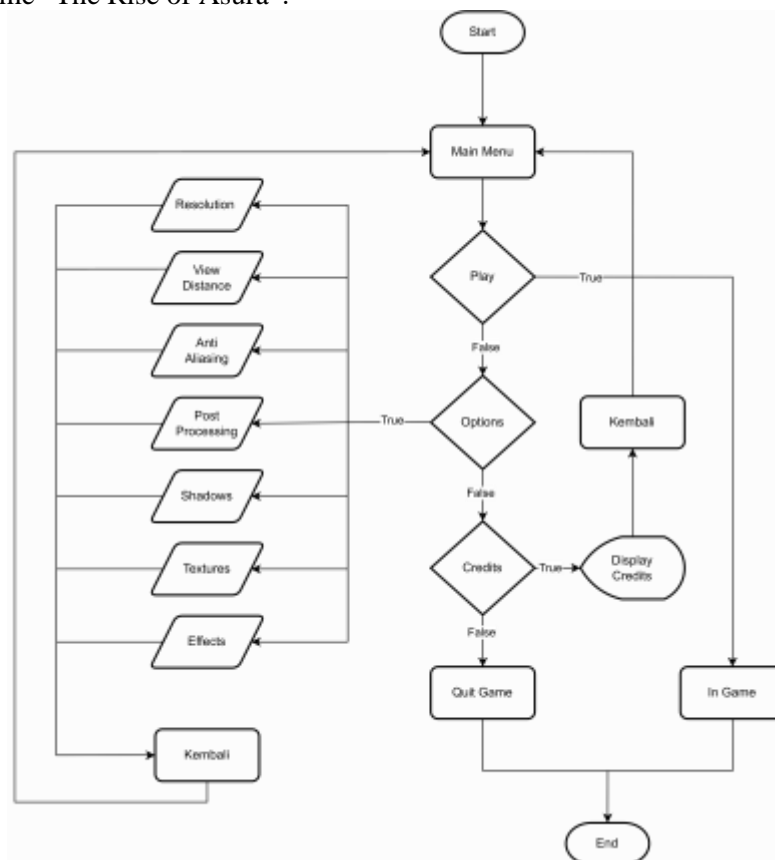


Fig. 2 Main Menu Flowchart

*name of corresponding author







This is anCreative Commons License This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

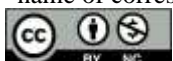
RESULT


To make it easier for the author to build this game so that it is structured and remains within the scope desired by the author, a game storyboard was created.

Table 1. Storyboard

No	Description	Picture
1	Baratha Village is located in a beautiful valley. This village is surrounded by dense forests and towering mountains. Baratha Village is protected by a sacred power called Angkara. Angkara is a force that comes from nature and provides protection for the village. The Azuras, a group of evil tribes, want to steal Angkara. They believe that Angkara will give them the power to rule the world.	
2	The Asura, a group of evil tribes, want to steal Angkara. They will destroy the Baratha village and threaten the world. People were running and screaming. The Asuras are attacking.	
3	Arka arrives at the village and sees that it is in chaos. Arka ran towards the Asuras and started fighting. This scene shows the scale of the conflict between Arka and the Azuras. The Asuras are powerful and cruel enemies. They have extraordinary power, and they will not hesitate to use it to destroy Arka and Baratha villages.	
4	The leader of the Asura attack troops attacked Arka. Arka tried to fight, but he was too strong. The leader of the Asura attack squad was a formidable enemy, and he succeeded in defeating Arka.	

*name of corresponding author



5	<p>Arka stood up and looked at the sky. He vows to take revenge and reclaim Angkara. This scene shows that Arka has not given up. He is still determined to protect Baratha village and reclaim Angkara.</p>	
---	--	--

The following are some of the characters that will be in the ANGKARA Game "The Rise of Asuras". The design and number of characters can change along with updates in development.

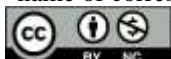
Table 2. Angkara Character

DISCUSSIONS

The use of the Real-Time Ray Tracing (RTRT) feature in the Angkara game is used to maximize lighting and shadows, making the feel more lively and real. Coupled with the application of AI to characters and enemies in the game by utilizing the Behavior Tree model, making the character's movements and abilities look real.

*name of corresponding author



This is anCreative Commons License This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

Real-Time Ray Tracing

For the map in this game, the author set a basic size of around 505 x 505 meters. To ensure players follow a predetermined path and avoid the open-world concept, the author limits the player's movement area to only the path that has been created. Because the author designed a dense forest, viewing the map from a top perspective is not possible because only trees will be visible. Therefore, the author will present several images from the player's perspective. The results of the Ray Tracing feature can be seen in the image below, showing real lighting in real-time.



Fig. 3 Village Condition

Figure 3 depicts the village gate because the conditions when Arka arrived at the village were late afternoon, the atmosphere looked a bit dark.

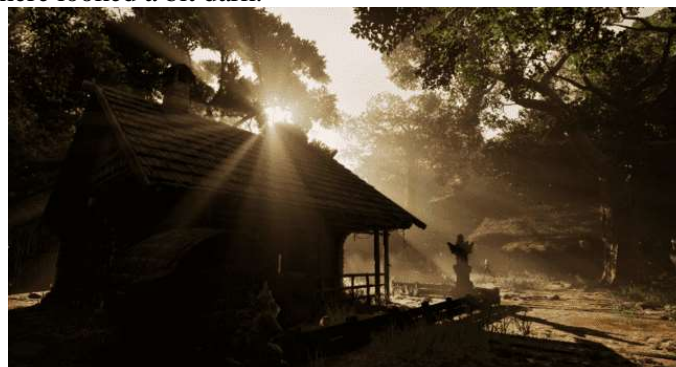


Fig. 4 Village

Figure 4 shows the conditions in the village by depicting the lighting system and lighting arrangements that the author has determined.

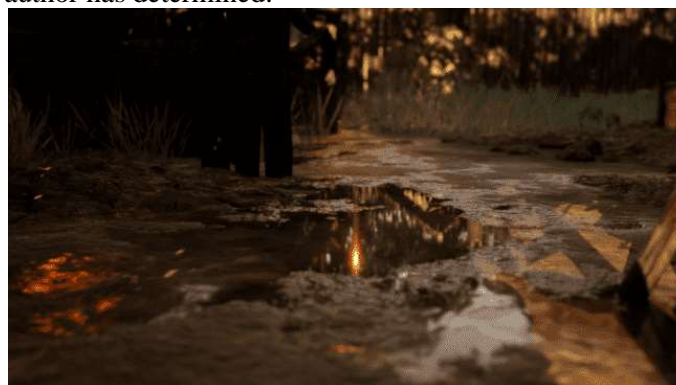
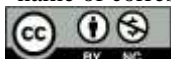


Fig. 5 Puddles

Figure 5 displays the results of applying Ray Tracing technology which can be seen in the reflection of puddles of water in the level.

*name of corresponding author



This is anCreative Commons License This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

Behavior Trees

Behavior Tree is a visual tool used to define the flow of AI behavior. Behavior Trees consist of various nodes that represent tasks such as searching for players, patrolling, or attacking. These nodes are arranged in a tree structure that allows the AI to switch between tasks based on certain conditions. As the name suggests, in the behavior tree there are only two types of files: behavior tree and blackboard. In Figure 6, the author created three behavior tree files. First, there is a behavior tree base that is responsible for managing general AI habits such as patrolling, investigating, and preparing to fight mode when it sees a player. Second, there is a behavior tree for enemies who attack from a distance. Third, there is a behavior tree for enemies who attack from close range. Additionally, the subtree folder only contains the logic of the general behavior connected to the base behavior tree.

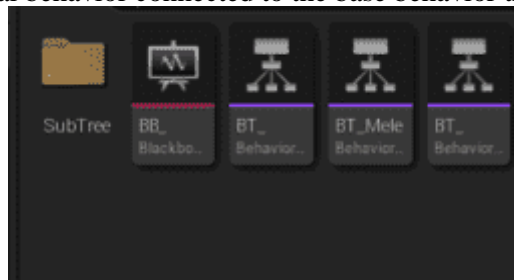


Fig 6. Behavior Tree

In game development, the combat system is a crucial component that allows players to interact with the environment and enemies. The following are several things related to the implementation of the fighting system in the Angkara Game.

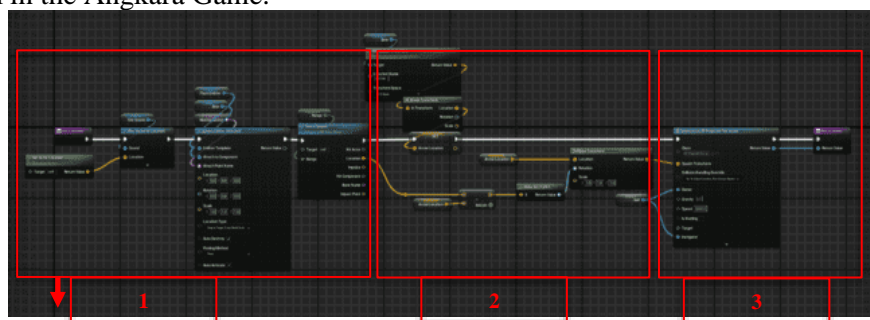


Fig. 7 Fire Function Logic

In Figure 7, the author displays a series of logic applied to the shooting or attacking function of the character Arka. In this function, the author performs the following steps:

1. Retrieving camera trace data: The author uses the Trace Camera function that was created previously to retrieve data about the camera trajectory.
2. Spawning Arrow Projectile Blueprint: Based on the data obtained, the author spawned a Blueprint from an arrow projectile that was also created previously.
3. Arrow Rotation and Location Adjustment: The rotation and location of the arrow are adjusted based on the location of the spawned arrow and the trace point that hits the target

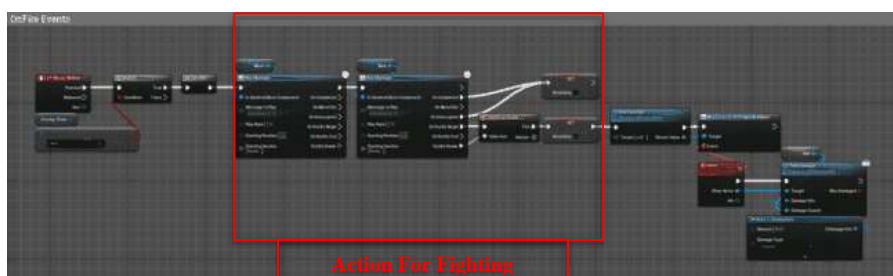
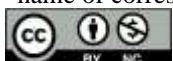


Fig. 8 On Fire Events

*name of corresponding author



This is anCreative Commons License This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

Next, in the Event Graph, the author connects character animation with fighting actions. For example, when the player presses the left mouse button while in Aiming or aiming mode, the character will play a shooting animation, then spawn projectiles and deal damage to the enemy. If the shot hits an object for which the author assigns physics, then the physics simulation will be applied.

Black Box Testing

Black Box Testing is used to test the feasibility of the game before field testing. Following are the results of black box testing.

Table 3. Black Box Testing

No	Testing Components	Results
1	Responsiveness Characters in the game immediately move in the direction of the button pressed without delay.	Validated
2	Basic Attack Combinations	Validated
3	Interaction with the Environment	Validated
4	Defence and Avoidance Systems	Validated
5	Basic Enemy Behavior The AI switches from a Passive state to Attack state and faces towards the player.	Validated
6	Ray Tracing	Validated

CONCLUSION

From the research carried out, the author completed the game development by optimizing the Ray Tracing feature in the action-adventure game with the title "Angkara: The Rise of Asura". This game was developed using Unreal Engine 5 with the GDLC (Game Development Life Cycle) development method. This game can be run on a Windows-based Personal Computer (PC). The results of black box testing show character responsiveness, basic attacks, interaction with the environment, defense, enemy behavior, and optimization of Ray Tracing state that it has been validated.

ACKNOWLEDGMENT

This research has been successfully carried out and developed, the author would like to express his deepest thanks to the Indonesian Ministry of Education and Culture for funding this research. And the author also thanks the Institut Bisnis dan Teknologi Indonesia for supporting this research.

REFERENCES

- Allsop, Y., & Jesse, J. (2015). Teachers' experience and reflections on game-based learning in the primary classroom: Views from England and Italy. *International Journal of Game-Based Learning*, 5(1), 1–17. <https://doi.org/10.4018/ijgbl.2015010101>
- Boros, E., Gurvich, V., Ho, N. B., Makino, K., & Mursic, P. (2023). Impartial games with decreasing Sprague–Grundy function and their hypergraph compound. *International Journal of Game Theory*. <https://doi.org/10.1007/s00182-023-00850-7>
- Dhote, D., Virmani, C., Rachna, M., Krishna, K. G., & Raghav, S. (2020). The Science of Ray Tracing. In *International Journal of Computer Applications* (Vol. 176, Issue 42).
- Fauzan, A. (2022). Pengembangan Game Action Sejarah Kerajaan Siak Sri Indrapura Bergenre Role Play Game. *Jurnal Ilmiah Teknik Informatika Dan Sistem Informasi*, 11(3), 753–762.
- Gintere, I., Rovithis, E., Bakk, Á. K., & Misjuns, A. (2024). ImGame Project: A Comprehensive Theory of Immersive Aesthetics and Innovation in Serious Gaming. *International Journal of Game-Based Learning*, 14(1). <https://doi.org/10.4018/IJGBL.338218>

*name of corresponding author



This is anCreative Commons License This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

- Gunawardhana, L. K. P. D., & Palaniappan, P. S. (2016). Using Multimedia as an Education Tool. *9th Annual International Conference on Computer Games Multimedia & Allied Technologies (CGAT 2016) Using, APRIL 2013*, 98–101. <https://doi.org/10.5176/2251-1679>
- Harahap, S. H., & Ramadan, Z. H. (2021). Dampak Game Online Free Fire Terhadap Hasil Belajar Siswa Sekolah Dasar. *Jurnal Basicedu*, 5(3), 1304–1311. <https://doi.org/10.31004/basicedu.v5i3.895>
- Laksmi, N. C., Fairul Filza, M., & Setiaji, B. (2023). Game Bertema Cerita Rakyat “Si Kerudung Merah Dan Sang Serigala” dengan Metode Pengembangan Game Development Life Cycle. *Media Online*, 4(1), 317–322. <https://doi.org/10.30865/klik.v4i1.1127>
- Limianto, R. B. (2019). Pengaruh Bermain Game online terhadap Disiplin Belajar Siswa. *KONSELING: Jurnal Ilmiah Penelitian Dan Penerapannya*, 1(2). <https://doi.org/10.31960/konseling.v1i2.351>
- McIntosh, T. H., Weinel, J., & Cunningham, S. (2022). Lundheim: Exploring Affective Audio Techniques in an Action-Adventure Video Game. *ACM International Conference Proceeding Series*, 155–158. <https://doi.org/10.1145/3561212.3561234>
- Mulati, Y. (2022). Analisis Penggunaan Teknologi Metaverse terhadap Pembentukan Memori pada Proses Belajar. *Ideguru: Jurnal Karya Ilmiah Guru*, 8(2), 120–128. <https://doi.org/10.51169/ideguru.v8i2.480>
- MUSIRAWAS Lubuklinggau, S., & Rahmawati, E. (2018). VIDEO GAME RPG NUSANTARA LEGACY. In *Jusikom : Jurnal Sistem Komputer Musirwas* (Vol. 3, Issue 1).
- Pasqualotto, A., Parong, J., Green, C. S., & Bavelier, D. (2023). Video Game Design for Learning to Learn. *International Journal of Human-Computer Interaction*, 39(11), 2211–2228. <https://doi.org/10.1080/10447318.2022.2110684>
- Ren, J., Xu, W., & Liu, Z. (2024). The Impact of Educational Games on Learning Outcomes: Evidence From a Meta-Analysis. *International Journal of Game-Based Learning*, 14(1). <https://doi.org/10.4018/IJGBL.336478>
- Rohmawati, I., & Menarianti, I. (2019). PENGEMBANGAN GAME EDUKASI TENTANG BUDAYA NUSANTARA “TANARA” MENGGUNAKAN UNITY 3D BERBASIS ANDROID. <http://www.jurnal.umk.ac.id/sitech>
- Wang, J., Xiao, H., & Wang, H. (2022). Ray Tracing Acceleration Algorithm Based on FaceMap. *Mathematical Problems in Engineering*, 2022. <https://doi.org/10.1155/2022/8961577>