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Analysis of level of detail as game optimization method in Mobile Legend's character

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Abstract:
Game is one of the entertainments that is sought after by people. Every game has given performance experience for its player that need to be well designed to reduce any issue. Optimization is essential for every game player to avoid any technical issue, including low frame rates and high battery consumption. One of the optimization methods is called Level of Detail (LOD). For this article, Mobile Legends is chosen as the topic. Mobile Legends is a Multiplayer Online Battle Arena game that used a real-time rendering that relies on the performance adjustment. Mobile games like Mobile Legends could benefit from implementing LOD. The goal of this article is to show the relation between LOD framework such as shader and Mobile Legend in-game settings. The method used is qualitative experiment research with game screenshots. Based on experiment, there are new analysis based on the proposed ideas. A combined framework is possible to be implemented to one type of the game visual settings.

Introduction

Game is a form of entertainment media that could be played traditionally or digitally. The development of mobile phone technology is one of the indicators of digital playable media enhancement where it creates new segment for game developer (Saputra and Andelina 2025). People perceive mobile game as an effective entertainment to release stress as it can be played anywhere and anytime, through experience caused by the player's interaction with the game itself (Ahmad 2020). Game is not only sought after by children, but also from every age range. The following statement is taken from a survey by Pew Internet & American Life Project towards adult in United States (Nadya and Paramitha 2014)The visual in the game is the part that comes first in terms of the gameplay, ensuring the game will have a best visual quality (Ahmad, Eko Prasetyo, and Inesia Linando 2022). One of the important aspects that influenced the gameplay stage is game optimization. Games with poor optimization method can cause a low frame rate, long loading duration, crashes, freezes, inconsistent and even high battery consumption. One of the optimization's goals is to make best use of the available resources including the memory space we used (known as RAM), memory bandwidth, etc. The greater number of resources that can be saved, the greater number of game's activity that can be implemented in the game (Aversa and Dickinson 2019). Thus, it is essential to have a smooth game experience in the player's device, especially in mobile phone. To create the following experience, the game needs to be designed with heavy optimization method.

Mobile devices have limitation in its system compared to computer, which consist of CPU (Central Processing Unit), GPU (Graphic Processing Unit) and memory. Thomas (2025) had divided the optimization techniques in mobile games, consisting of these:

1. Reducing the number of Polygon: Using a simple model.

2. Texture compression: reduce the size of images to save memory.
3. Efficient scripts: to minimize the high budget for every fame.
4. Garbage collection management: to minimize object duplications to minimize frame drops.
5. Frame rate control: resize the frame rates to save mobile's battery power.

According to David Luebke (2003), the processing of render is important for game efficiency, and have impact on Level of Design. LOD (Level of Design) can benefit even in rendering of visual effect and animation in non-interactive offline game. The basic concept of LOD can be seen in Figure 1.1 below. When rendering a real-time scene in a game, few less detailed 3D asset is used as a representation of single object, each object has different versions of representation. The distance of player viewing angle with the game object influenced the LOD version.

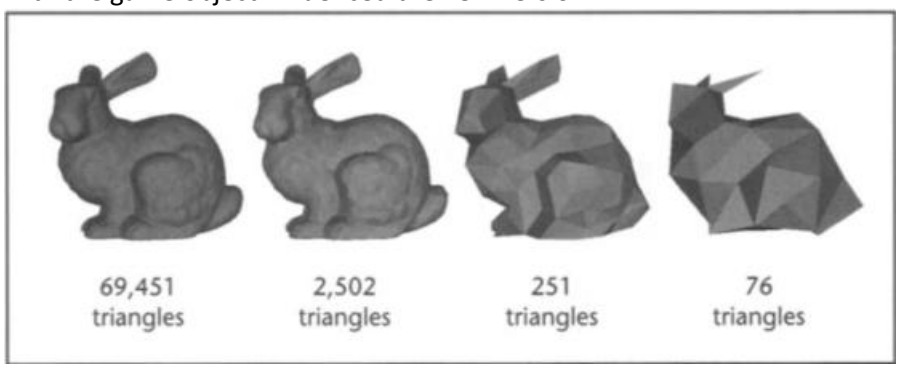


Figure 1 Basic Concept of LOD
(source: Luebke 2003)

The purpose of LOD is that no matter how the model is implemented in the game, providing the player's experiences is the right thing. Most games, players could only experience in things they can hear and see. For example, in first shooter game the players only see their surroundings as it is restricted into a small region. (Chenney 2001)

Level of Detail (LOD) technique can impact the gameplay smoothness, especially in device that required heavy optimization. Not only in computer games, but mobile games also benefit from LOD. Compared to computer, mobile phone is more powerful and has longer stand-by time, making 3D game possible to be played. (Hu and Zhu 2014)

One of the mobile games with numerous players online is Mobile Legends: Bang Bang. Mobile Legends game is developed by Moonton, a game company based in China and released its Android version initially in China, Indonesia and Malaysia on July 11, 2016. This game later released its iOS version on November 9, 2016. (Al Mawalia 2020). The game has about 170 million active players and has been downloaded 35 million times. (Trisdasari et al. 2023)

Mobile Legends is a 3D smartphone-based game designed with a virtual control pad, where two teams compete to attack and defend their respective bases. The battlefield is divided into three lanes—top, middle, and bottom. Each team consists of five players, each controlling a unique hero, supported by smaller AI-controlled units that assist in combat. As a popular online game, Mobile Legends introduces players to the MOBA (Multiplayer Online Battle Arena) genre, blending elements of Real-Time Strategy (RTS) and Role-Playing Games (RPG). Players must collaborate strategically, using heroes with distinct roles, to defeat the opposing team and destroy their base. (Al Mawalia 2020)

Mobile Legends: Bang Bang is made using Unity engine. In 2019, Moonton has made the game 2.0 update that has powered by Unity engine 2017 version. It is said that the game could get better looking graphics and the loading speed has been increased to at least 60% compared to before. The game loading time has reduced from 15 seconds to just 5 seconds, while the app launch time has reduced from 25 seconds to just 10 seconds. (Azis 2023; Low 2019)

Goal of the Journal Article

This journal article is necessary as most mobile game player is not aware about the important of game optimization in the game, which they have played that could lead to device's health condition if not properly optimised. Player could use this article as a guide to appropriate game performance setting to achieve their own personal preference. Not only targeting to the game's player, but this article can also guide game developers to create a more efficient gameplay. As a part of game optimization method, the LOD (Level of Design) is essential aspect that should not be overlooked.

Another goal of this article can be seen as an educational purpose on how the Mobile Legend game works as one of the mobile role-playing games with numerous players. The game's accessible design and competitive gameplay have contributed to its widespread appeal among mobile gamers globally.

There are questions for this analysis regarding this analytic journal that needs to be answered:

1. How can the Mobile Legend's in-game performance setting be related to the frameworks of Level of Detail (LOD)?
2. How will the characters have influenced by the LOD frameworks in the in-game performance setting?

Related Works

Although no similar research or article that explained about a specific mobile game's level of detail, there are few relevant articles, books and research about LOD as a game optimization method. Further description about the related works will be shown in table below.

Table 1 Related works with similar topic

No	Title	Topic	Source
1	Improving Mobile Game Performance with Basic Optimization Techniques in Unity	Optimization techniques can be applied in different stages of the game development. The authors developed and designed a shooter game, intended for Android mobile devices. Two versions of the game were developed to study the differences in performance: one version that applies basic optimization techniques, such as low poly count for the models and the object pooling algorithm for the enemy's spawn; and one where the optimizations were not used	(Koulaxidis and Xinogalos 2022)
2	Level of detail AI for virtual characters in games and simulation	LOD application into Artificial Intelligence (AI) of virtual character. LOD is used to simplify the character's behaviour in an application.	(Wißner, Kistler, and André 2010)
3	Level of Detail for 3D Graphics	A book with detail explanation of Level of Detail (LOD) comprehension, from history to frameworks and example in game scene. LOD can help reduce the number of polygon while maintaining the game FPS.	(Luebke 2003)

4	Optimasi Level of Detail dan Occlusion Culling dalam Game Aaron Lost in the Jungle	A comparison of LOD and Occlusion Culling towards game optimization effectivity. Using quantitative with experimental approach on Unity features.	(Anderson Simatupang and Amalia Purnamasari 2024)

(source: personal documents)

Method

This study is made using a qualitative experiment approach, through implementation of LOD technique with new framework proposal and personal game screenshots of Mobile Legend. A qualitative experiment is a research method that combines qualitative strategies with experimental design to develop a phenomenon. (Robinson and Mendelson 2012). The qualitative experiment is based off qualitative design as its root. Even though there is not one right model for a qualitative design, there are three main reasons according to Maxwell (2012):

1. Highlighting the key design issues clearly. These issues are likely to be ignored and can be handled with systematic manner.
2. Emphasizing the interplay between design components.
3. Providing a framework for structuring and justifying qualitative research proposals.

For source of framework of LOD, a literature review is done, and data is collected through analysis by comparing each screenshot of game scene that contains character with its level of detail and Frame per Second (FPS) while on play mode.

Luebke (2003) divided LOD frameworks into six, which consist of: discrete, continuous view-dependent, higher-order surfaces, shadow and shader LOD. Details on each framework will be described below.

1. Discrete LOD

   This framework refers to traditional approaches on LOD. This approach is done by creating multiple versions of every object in offline mode. For each version, the rendering speed is increased, and the number of polygons is reduced. At the game runtime, the system chooses the appropriate version to display, balancing visual fidelity and performance. This LOD only works for game that does not need real-time rendering such as offline mobile game. Example of discrete LOD can be seen in figure 2. Object (a) in figure 2 shows 3D model with lower poly count compared to object (b). Model with lower poly count will be shown in game scene if the device could not handle the higher quality model from the start. Two variations of the 3D model cannot be used at the same time; it must be switched.

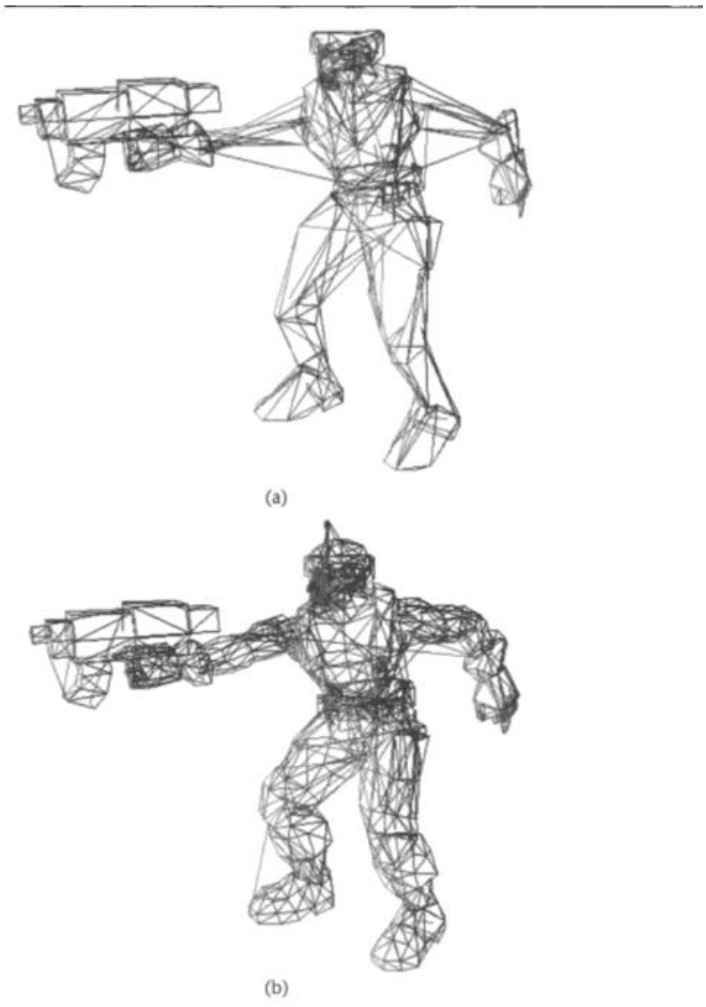


Figure 2 Example of Discrete LOD in trooper 3D model
(source: Luebke 2003)

2. Continuous LOD

This approach refers to LOD with flexibility in structure, enabling a smooth transition between detail levels during rendering. This LOD consist of combining few different object variations on the same time. It is efficient for streaming large models and supports progressive refinement and loading time. Continuous LOD is appropriate for games with real-time rendering such as online open world game where rendering constantly occurred each time the main character exploring the game scene.

3. View-dependent LOD

An enhancement of continuous LOD, this method dynamically adjusts detail based on the viewer's position and orientation. It is anisotropic, which means that different parts of the model can have different levels of detail. This approach optimizes polygon use, enhancing visual quality in the game scene. The figure below shows example of object with view-dependent LOD. Figure 3 shows that the area nearby the player in the bottom of the right has more polygons than the further upper section. This method can help in a stable FPS (Frame per Second) for game that demanding high resolution visual.

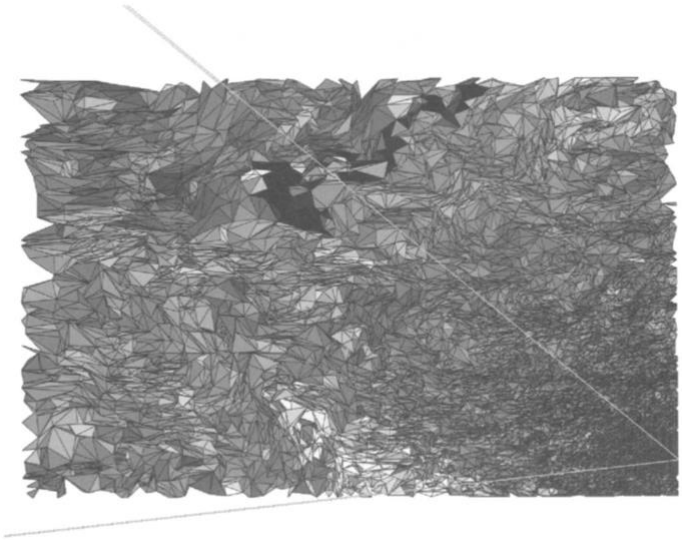


Figure 3 Bird eye view of terrain models with view-dependent LOD
(source: Luebke 2003)

4. Higher-Order Surface

   This approach is similar to displacement mapping or Bézier patches. This includes surface rendering, which found in new advanced hardware and hampered by artistic challenge than technological ones. Artists still use traditional way like polygon modelling due to its flexibility and familiarity. For higher-order surface method, a new technique is developed to replace the old polygon modelling, and it is called curved modelling. Curved surfaces may become more practical, especially for modelling organic characters.

5. Shadow LOD

   This approach uses simplified models to generate shadows more efficiently and can speed up rendering without losing visual quality. Example of shadow LOD can be seen in figure 4 below. Each variation shows a different clarity of shadows underneath the character.

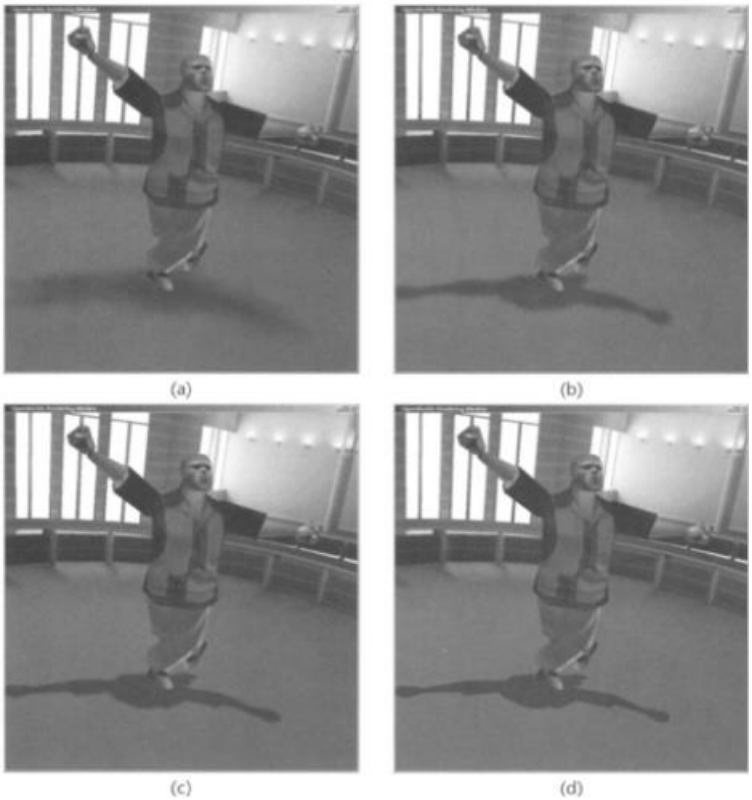


Figure 4 demonstration of detail in (a)frame rate 12Hz to (d)frame rate 3.05Hz (source: Luebke 2003)

6. Shader LOD

Not only in modelling aspect, LOD also extends across rendering, lighting, and audio system. Shader LOD targets on how efficiently pixels are processed. The more textures or effects used per pixel, the higher the rendering cost. For example, four textures make rendering roughly four times heavier than one.

The data collection for this analysis is also going to use BlueStacks app player. BlueStacks acts as emulator to simulate any Android application or games that could be played in dekstop version. BlueStacks is used to show the advanced graphic and FPS settings that could not be shown in the original mobile version of Mobile Legend. The table below shows suggested implementation between frameworks of LOD based on book by Luebke with Mobile Legend's in game custom performance setting.

Table 2 Suggested frameworks related to in-game performance settings

No	LOD Framework	In Game Performance Settings
1	Higher Order Surface	Model Quality
2	Shader LOD	Effects Quality
3	Shader+Higher Order	Default Outline (On/Off)
4	Shadow+Discrete LOD	Default Shadow (On/Off)

(source: personal documents)

Figure 5 below shows the in-game settings that is used as a parameter to determine the LOD framework. The settings are limited to basic tab, with adjustable graphic quality. The default section that consists of outline

and shadow adjustment is also used for this LOD analysis.

Figure 5 Basic tab consists of graphic adjustments in Mobile Legend settings
(source: Mobile Legends 2025)

Result and Discussion

Screenshots are made in the gameplay mode to be compared to the LOD frameworks. First performance setting to be made is the model quality that relates to higher order surface approach. Before each screenshot could be made, a BlueStacks performance settings is set to show a better game visual and on-screen FPS. As seen on figure 6, the adjustment has three main part which consist of CPU allocation, memory allocation and performance mode.

In figure 6, there is CPU allocation adjustment that consist of cores usage. CPU allocation has another terminology called CPU scheduling. To make sure that it is used efficiently, the operating system shares the CPU among several active programs. Using a special rules and algorithms, operating system ensures resources are handed out in a way that keeps things smoothly and fairly for every process. (Haldar 2016). The frame rate was set to 120 to see the highest possible FPS on mobile gameplay, as it is usually capped at 60. On the bottom section of the setting, the 'display FPS during gameplay' adjustment is turned on.

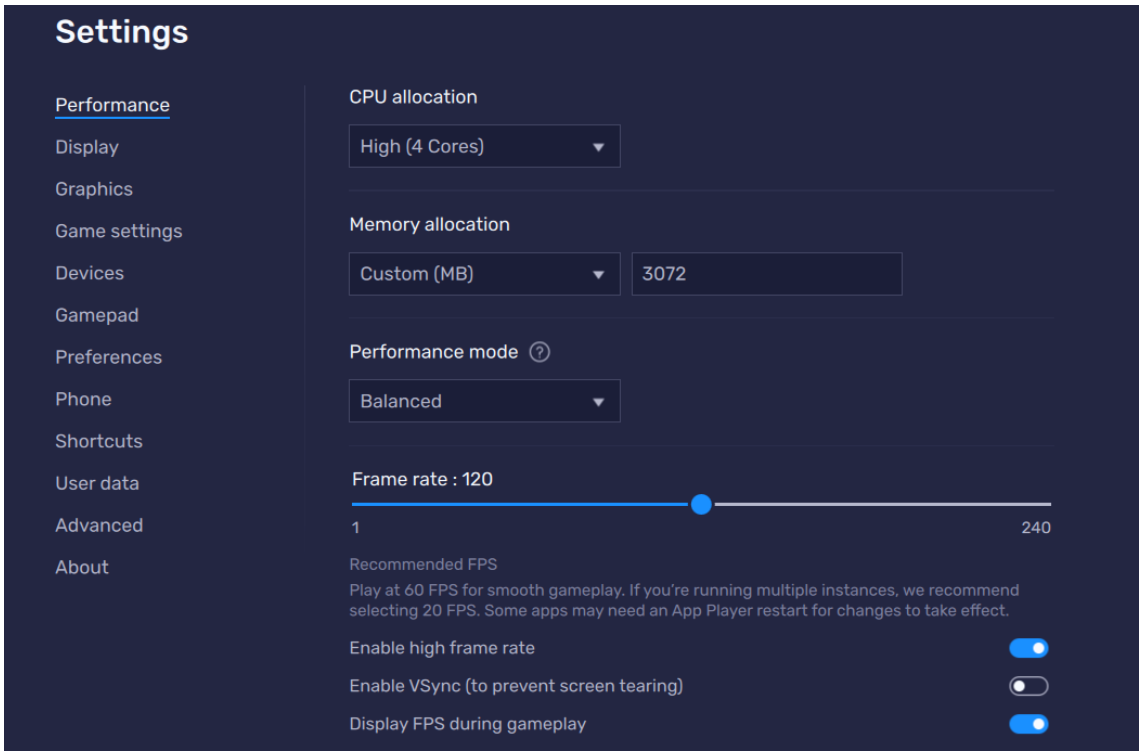


Figure 6 BlueStacks performance settings are set before starting the game
(source: BlueStacks 2025)

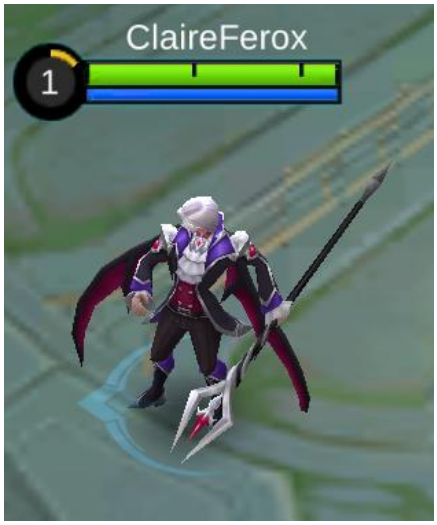
LOD Frameworks on Model Quality

The first frameworks experiment is by testing the lowest quality in all performance settings the model quality is set to low to see the 3D character model on low LOD. As the polygon count cannot be seen in the game, I used the high order surface approach. On figure 7(a) it shows texture density is low, and the 3D model have sharp edges on the wings and the weapon's handle part. The overall model design shows blurry outline. Figure 7(b) shows the in-game performance adjustment to make the low-quality 3D models.

(a) (b)

Figure 7 Screenshot of (a) character in low model quality and (b) custom settings of the performance quality
(source: Mobile Legends 2025)

The next screenshot is by setting the model quality to 'standard', the highest for the 3D model on the game scene. On figure 8(a) it shows the overall 3D model has more defined outline, compared to figure 7(a). The weapon's handle part does not show any distorted lines, and the purple clothing part looks more vibrant. Figure 8(b) shows the adjustment made on the model quality section, which set to 'standard' or the highest.



(a)

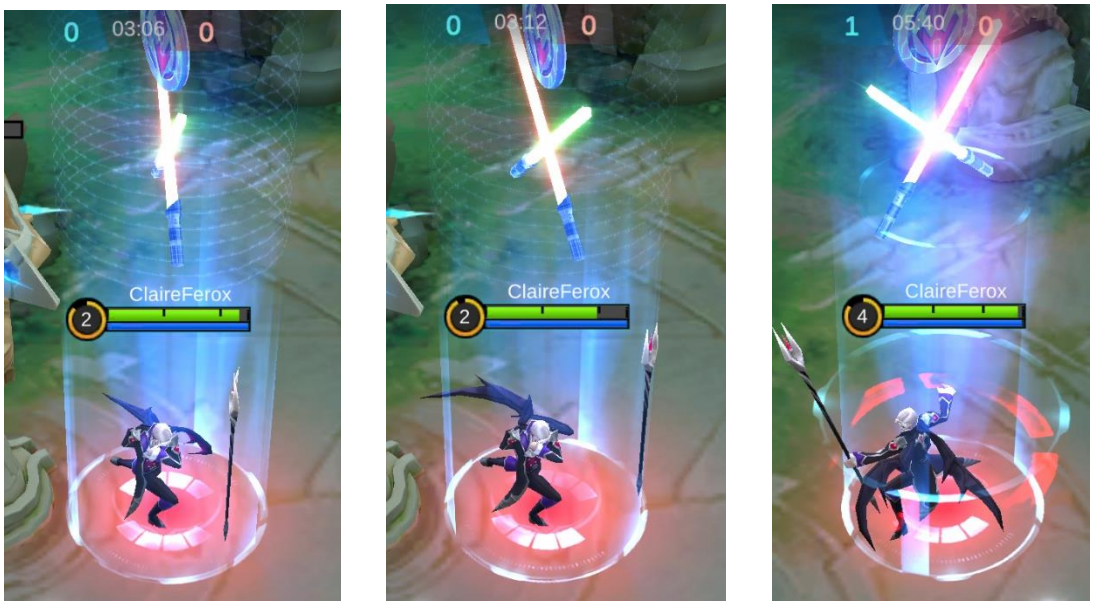
(b)

Figure 8 Screenshot of (a) character in standard model quality and (b) custom settings of the performance quality
(source: Mobile Legends 2025)

LOD Frameworks on Effects Quality

The second frameworks experiment is by adjusting the in-game effect quality and referring that to shader LOD approach. The effect sample used is the character's recalling scene where there is a surrounding visual effect on the character, followed by some animation on both character and visual effects. On figure 9(a) shows the blurry outline of the sword that lacks definition. In relation with shader LOD, the glow effects on the swords become more vibrant and clearer as the in-game effects quality becomes higher. The pixel density increases alongside the effects quality. There are additional ring effects on the character on figure 9(c). Pixel density determines how many pixels can fit into an inch of a screen, influencing how sharp an image appears. In digital art, denser pixels create smoother dan more detailed artwork. (Huys 2024)

Another clear example of the difference lies on the bottom outline of the blue ring effect on the ground. In figure 9(a) the bottom outline has lower opacity and jagged edges compared to figure 9(b) and figure 9(c). As the effect quality increases, the rendering looks sharper and have more defined texture on the 3D model.



(a) (b) (c)

Figure 9 Comparison of recalling effects on (a) low quality effects (b) medium quality effects (c) high quality effects
(source: Mobile Legends 2025)

LOD Frameworks on Default Outline

Mobile Legends gives a unique performance adjustment where player could set the outline of the character. For this feature, the proposed LOD frameworks are combination of shader LOD and higher order surface. Figure 10(a) shows rendering of characters with outline that attached to the 3D model's movement. The outline can be seen as a visual effect that constantly appear and as a surface real-time rendering which contain a floating curve line that attaches to the 3D model asset. Real-time rendering consists of render data that only load when the playable character is nearby.

(a) (b)

Figure 10 screenshots of rendered character with (a) outline and (b) no outline
(source: Mobile Legends 2025)

LOD Frameworks on Default Shadow

Another performance setting in Mobile Legends is default shadow. For this approach, the proposed frameworks are shadow and discrete LOD. The shadow LOD framework cannot be implemented fully as there is only one variation of shadow setting. As for the discrete LOD, the shadow in both low (figure 11) and higher quality on figure 12 shows similar render images. The shadow

definition looks pre-determined, affected by the device's specification. This pre-determined render data can be connected to discrete LOD framework.

(a) (b)

Figure 11 screenshots of (a) Default shadow turned on and its (b) Performance adjustments (source: Mobile Legends 2025)

(a) (b)

Figure 12 screenshots of (a) Default shadow higher quality and its (b) Performance adjustment (source: Mobile Legend 2025)

Overall Visual Performance

The overall Mobile Legend performance can be determined using the high frame rate (Frame per Second). FPS parameters exist via settings on BlueStacks app player. The higher each aspect quality, the higher the FPS is. The low-quality performance adjustment in figure 13 has created a fluctuate FPS rate, but it is capped to less than 60. In higher quality performance adjustment in figure 14, the FPS rate is shown greater than 60.

When changing the high frame rates setting in Mobile Legend, there is pop-up notifications containing warnings about crash or lagging in device with lower specifications. This notification means that smoother gameplay needs high frame rates with adequate device.

Figure 13 screenshot of FPS rate at lower visual quality
(source: Mobile Legends 2025)

Figure 14 screenshot of FPS rate at higher visual quality
(source: Mobile Legends 2025)

Conclusion

Mobile Legends is one of the mobile MOBA (Multiplayer Online Battle Arena) game with huge amount of player. Mobile Legends is released for the first time in 2016 on China, Malaysia and Indonesia. As the game is played online, the images are rendered using real-time rendering. To do that, the need to make the gameplay smooth and avoid any technical issue is needed. Optimization method is essential to make player's game experience better. LOD (Level of Detail) is one of the methods. LOD consist of few frameworks, such as discrete, higher order surface, continuous, view-dependent, shadow and shader. In Mobile Legends itself, there are visual adjustment similar to LOD frameworks.

This journal article has few proposed ideas to analyse the relation between LOD frameworks and Mobile Legends in-game performance settings toward the character's gameplay. For the analysis method, the author used qualitative approach with experimental and literature review. The experimental method is done by doing the actual gameplay with screenshot feature. To enhance the visual quality, the author has used BlueStacks app player installed on personal computer to replicate the player experience in mobile version. BlueStacks app also helps providing the FPS rate of the game while doing real-time rendering through the gameplay.

The results of the experimental process have created a new approach regarding how the character's influenced by Level of Detail frameworks. The experiments also show how LOD framework could be combined to make one visual adjustment in Mobile Legends as one framework could not be implemented thoroughly.

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