A Study on the Effective Viewport Resolution Scaling of the Hardware Scaler Technique to Reduce Power Consumption in Mobile GPU

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***Abstract* - In recent years, three-dimensional (3D) game applications have grown in popularity with improvements in the development of smart phones. However, the users of 3D games were often unsatisfied with the limited size of batteries. This paper introduces a viewport resolution scaling of the hardware scaler technique to reduce the power consumption of 3D game applications, while addressing the limited size of batteries. We are analyzing the relationship between the image quality and power consumption based on the resolution factor. As a result, we propose the optimal resolution factor. The resolution factor obtained in this experiment minimizes power consumption and maintains image quality, which is comparable to the original image.**

Keywords* - *Viewport resolution scaling; hardware scaler; low power

I. INTRODUCTION

Mobile device technology has recently evolved because these mobile devices are used on a daily basis. In mobile devices, the internal battery acts as a source of the electrical energy supply. Since the amount of power in the internal batteries of mobile devices is limited, power efficiency is a key component of mobile devices. The speed at which technological development of mobile device batteries occurs is relatively slow when compared to the developmental speed of semi-conductor integrated circuits. A paper of mobile low power is needed[1].

The speed of semi-conductor development has resulted in application processor(AP) development. AP development has also led to the GPU development, which controls graphic-related tasks. The GPU is the main processor that power consumption because compared to the CPU, the physical area of the GPU has increased[2]. Also the main cause of the power consumption is a resolution. The display size of the mobile device has increased the resolution. As a result, research on the topic of mobile GPU low power, which is concerning resolution, was needed[3].

Influential papers related to this topic were [4, 5, 6]. [4] was a paper from 2014 on the topic of viewport resolution scaling. However, the GPU utilization was no reduction, if the resolution was greater than 445ppi and the number of triangles exceeds 1600. And it was difficult to apply to an actual mobile environment. The study was completed by [5] on resolution scaling using framebuffer object(FBO) does not directly address the relationship between video quality and power consumption. [6] was discussed an application in which users can manually control the resolution and frames per second(fps). However, the use of this application was limited to specific devices and game applications.

This paper presents a resolution factor that is applicable to the mobile environment. This resolution factor minimizes power consumption, as well as alterations in video quality that are caused by variations in resolution.

This paper outlines a viewport resolution scaling technique applying a hardware scaler in section 2. The experiment and its impact on power consumption and changes in video quality (which are also caused by alterations in resolution) are discussed in section 3. The conclusion and directions for future work are included in section 4.

II. VIEWPORT RESOLUTION SCALING TECHNIQUE USING THE HARDWARE SCALER

Because video and display devices are produced in different sizes, the ratios or the pixels may not consistently match the requirements of video and display devices. The hardware scaler addresses this issue. The force of the hardware scaler stretches or shrinks the video, changing the video's scale to the required size.

This paper applies the hardware scaler at the JAVA code level, which is an API level. This application is shown in Figure 1. The viewport resolution scaling process applying *setFixedSize()* in *GLSurfaceView* that inherits *SurfaceHolder* and *SurfaceView*. Figure 2 is a result of reduced to 25% the resolution of the GFx game engine application in Nexus5, which has a resolution of 1776 x 1080 size.

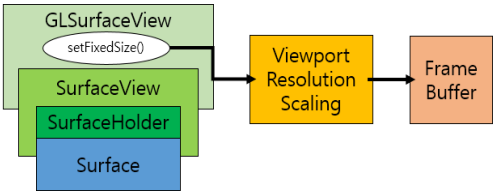


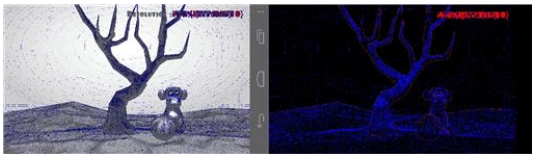
Figure 1. Overview of viewport resolution scaling

Figure 2. Hardware scaler results

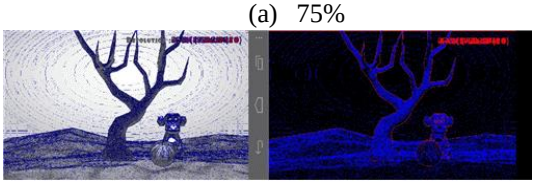
III. EXPERIMENT AND RESULTS

We propose a resolution factor that can minimize image quality changes and power consumption according to the resolution. To this end, we conduct a measurement experiment of video quality change and power consumption.

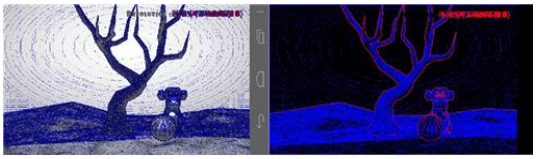
Measuring the change in video quality is completed by comparing the original image to the Peak Signal-to-noise Ratio(PSNR) value. Figure 3 shows the result comparing with the image of resolution factor 75%, 50% and 25%, based on the image of resolution factor 100%. The pixel value of the same position can be different, if the resolution factor of two images are different. The number of the changing pixel can be increased, if the resolution factor is decreased. Another measurement of changes in video quality is calculated of the PSNR value. A PSNR value of 30–50dB is indicative of normal image quality and is comparable to the original image. As the PSNR value increases, the difference in the quality in comparison to the original image decreases. Figure 4 shows PSNR of result images with resolution factors from 75% to 20%, which are calculated with image of resolution factor 100%. If the resolution factor is between 50% and 75%, the quality of the image is normal.



(a) 75%



(b) 50%



(c) 25%

Figure 3. The results of image comparison by resolution factor

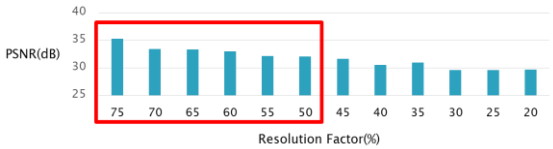


Figure 4. Calculation of the original image and the PSNR

The Trepn Profiler from Qualcomm is used to provide the power consumption measurements. By using the Trepn Profiler, the power consumption reduction ratio of the image of resolution factor 75%, 50% and 25% is calculated based on the image of resolution factor 100% (see Table 1).

Table.1. Power consumption reduction ratio

	Hardware Scaler			
Resolution Factor (%)	100	75	50	25
Power Consumption Reduction Ratio (%)	0	0.25	30.40	48.10

IV. CONCLUSION AND FUTURE WORKS

In this paper, we propose the viewport resolution scaling of the hardware scaler technique. Resolution factor that can minimize the power consumption and the change in video quality is a 50%. As a result, power consumption is reduced by 30.4%.

The proposed technique does not apply to applications that do not use *GLSurfaceView*. Future studies should address the ability to apply the viewport resolution scaling technique in all applications.

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