# Performance comparison for tasks executed on GPU, CPU and Remote in mobile devices

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## Introduction

Mobile devices have become widely popular over the last decade. It is not unusual to see a person using an smartphone or a tablet for their daily work.
Many of these devices have a high enough computing capacity to support an extensive amount of applications.
However some applications may perform better when running on the GPU and some other may perform better when running on the CPU.

## Implementation

A simple image processing algorithm was implemented, an image (1920x1080 pixels), from the camera, is filtered using a convolution matrix. The convolution matrix values change from one filter o another. The filter is applied to each pixel of the image.

We tested the algorithm implementation in three contexts:

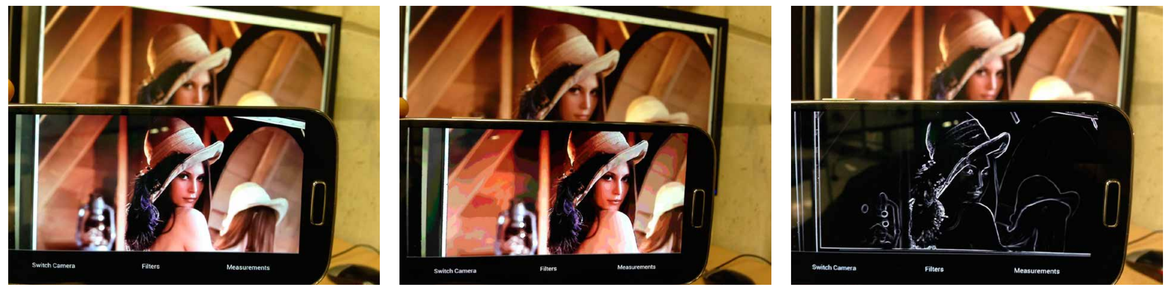
**1) CPU (Central Processing Unit):**
The algorithm is executed in the mobile CPU (Quad-core Cortex-A15), we use OpenCV and Android NDK for this propose.

**2) GPU (Graphic Processing Unit):**
The algorithm is executed in the mobile GPU (PowerVR SGX 544MP3), we use OpenGL and GLSL.

**3) Remote:**
The algorithm is executed on a server where the image is processed and sent back to the mobile thought Wi-Fi.

We used a Samsung Galaxy S4, Model GT-I9500 with a factory 3.8V Li-ion Battery 9.88Wh.

In Figure 1a we show the original image (no filter applied) from the camera, in Figure 1b we show a resulting filtered image from a "toon" filter and in Figure 1c we show the resulting image from an "edge" filter.




(a) (b) (c)

**Figure 1.** Running Application

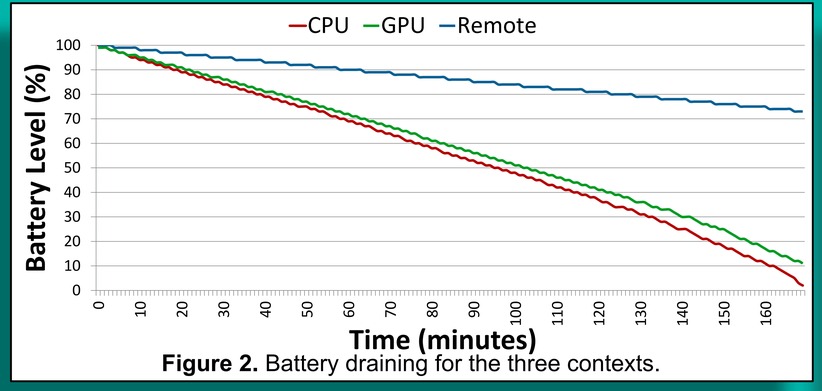



**Figure 2.** Battery draining for the three contexts.

## Battery Draining

Mobiles devices have a limited source of power, so it is important for an algorithm to reduce the amount of power it needs to be executed.
The algorithm was executed continually in the three contexts for a period of 3 hours. As shown in Figure 2, the execution on CPU drained completely the battery followed by the execution on GPU that left an 11% of battery level remaining. Remote execution had the least battery draining by leaving a 72% of battery level remaining.

## Processing Time

We also measured the time it takes to filter one image, and tested the same contexts for the algorithm.
We found (Figure 3) that Remote execution takes about 1.2 seconds to filter and send the image to the mobile, while CPU execution takes 0.98 seconds to filter the image. GPU execution had a outstanding time of 6.17ms, making it 160 times faster than CPU, which is not a surprise as image processing algorithms are easily parallelizable on GPU.

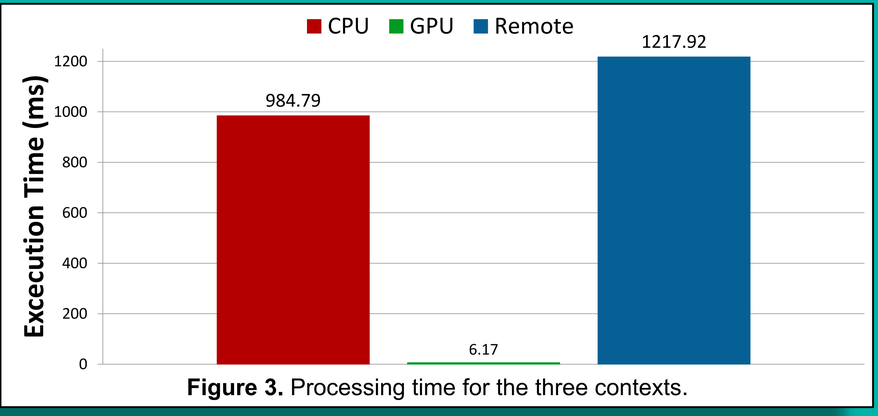



**Figure 3.** Processing time for the three contexts.

## Conclusions

Mobile devices are capable of executing simple and complex tasks, some algorithms can be benefited when running on CPU, GPU or Remote. Finding the appropriate context for an algorithm will increase the performance of the task. However, more complex algorithms may require of the use of a combination of contexts to find the best performance.