High Dynamic Range Imaging by Heterogeneous Computing in Mobile Devices

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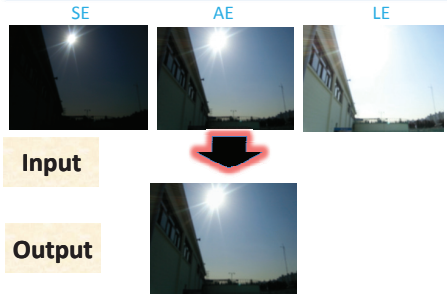
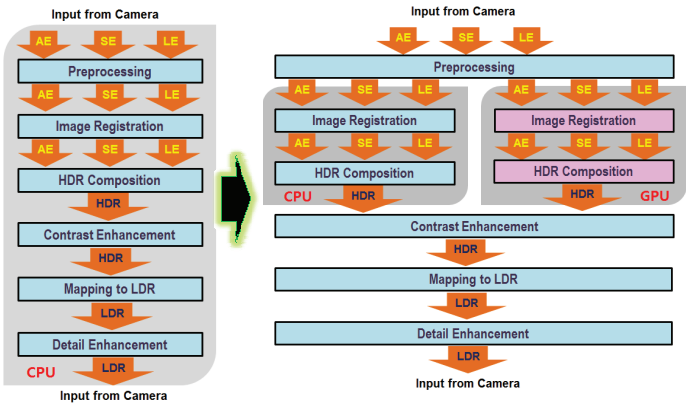
Overview

- In mobile environments, achieving high performance with low power consumption is a challenging task.
- As GPUs have emerged as a helping hand to CPUs for general computation since GPUs can perform the same computational loads as CPUs with lower clock frequencies, we propose a solution to construct CPU- and GPU-enabled high dynamic range imaging by using general purpose GPU (GPGPU) computing in a heterogeneous environment to accomplish both goals.
- Depending on the complexity of the module, the workload is distributed over CPUs and GPUs.
- The performance of the proposed solution is compared against the baseline CPU HDR (multi-threaded and SIMD optimized) in terms of elapsed time and power consumption.
- Experiments on 8 MP, 9.8MP and 13 MP images show that our method achieved the 24% performance enhancement and 18% power savings on Qualcomm's AP.
- We expect this will add another to a few reported GPGPU solutions in the mobile environment and will overcome CPU's maximum frequency limitations due to heat and power dissipation.

Input and Output



Parallel Architecture

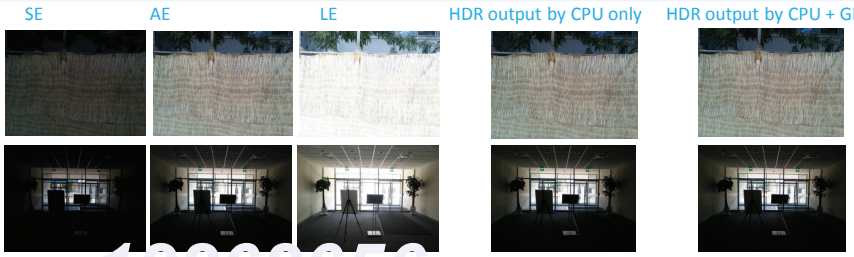


- **The criterion for load distribution**: The amount of time taken for execution of the module and the possibility of parallelization
  - If the processing time for the module is less, then the gain obtained by doing a part of the module will be less than the offset required for enabling GPU processing.

AP Specifications Used

AP Chipset	Qualcomm's MSM 8974	Samsung System LSI's Exynos 5420
CPU	Qualcomm Krait 400	ARM Quad Cortex A15 + ARM Quad Cortex-A7
CPU Cores	Quad core	Octa core
GPU	Adreno 330	Mali T628MP6
Memory	2 LPDDR3	2 LPDDR3e
Camera	13 MP	13 MP

HDR Results & Comparison



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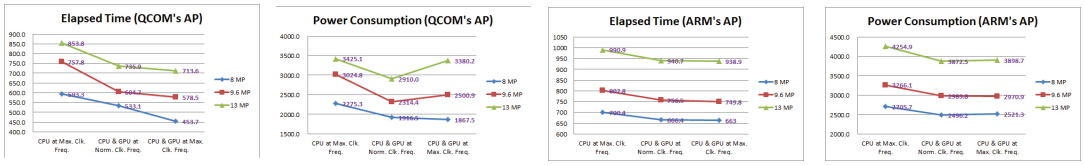
Performance Measures (Elapsed Time & Power Usage)



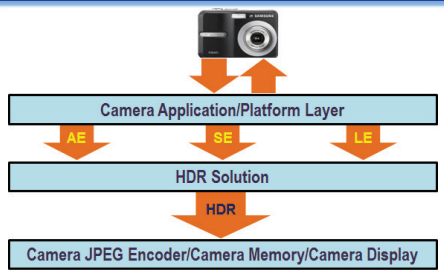
Savings of Elapsed Time (QCOM's AP)	CPU at Max Clk. Freq.	GPU & GPU at Max. Clk. Freq.
8 MP	10.1 %	23.5 %
9.6 MP	20. 2 %	23. 7%
13 MP	13.8 %	16.4 %

Savings of Power Usage (QCOM's AP)	CPU at Max Clk. Freq.	GPU & GPU at Max. Clk. Freq.
8 MP	9.4 %	17.9 %
9.6 MP	17.8 %	17.3 %
13 MP	12.8 %	1.3 %

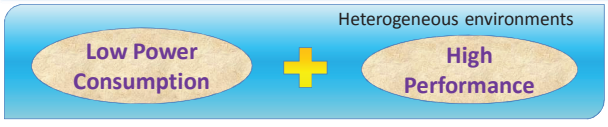
Savings of Elapsed Time (ARM's AP)	CPU at Max Clk. Freq.	GPU & GPU at Max. Clk. Freq.
8 MP	4.9 %	5.3 %
9.6 MP	5.8 %	6.6 %
13 MP	5.1 %	5.2 %

Savings of Power Usage (ARM's AP)	CPU at Max Clk. Freq.	GPU & GPU at Max. Clk. Freq.
8 MP	7.7 %	6.8 %
9.6 MP	8.6 %	9.0 %
13 MP	9.0 %	8.4 %

Architecture Overview



Conclusions



= **Achievable!**

- As the complexity of mobile devices gets increased, low power and high performance become major goals of mobile solution providers.
- According to our research, computation in heterogeneous environments can increase performance and reduce power consumption.
- The performance of GPU computing is heavily dependent on
  - The level of code optimization (Requires the knowledge of the hardware architecture)
  - The GPU hardware's performance
- Performance variations of a GPU should be minimized to guarantee application performance.