# Brief status report

## Status update: as well as a few paragraphs about the related work. If you are working alone, I’d like to see at least 5.

## A list of references with the work cited.

## Can be email.

An short example of roughly what I expect:

Our research involves making an open-source low-powered video game that will run on an embedded Raspberry Pi board. Weaver[1] wrote a cross-platform assembly language game for the ARM platform but unlike us he did not characterize the power consumption while running. Mallow and Snap[2] look at optimizing a Ray-Tracing program on the Tegra2 ARM system. This is similar to our project, only they looked solely at ray-tracing applications and not video games.

[1] V. Weaver. "Tom Bombem: An ARM Implementation of the Classic DOS game." Proc. of the 4th Conference on Useless Video Games, p 10-18, May 1996.

[2] M. Mallow and G. Snap. "Optimizing Energy Consumption on the Tegra2." Journal of Embedded Programming, p11-19, Vol 1 Issue 15, June 2010.

My research is focus on the power/energy implications on GPU embedded Raspberry Pi B+ board.

The Raspberry pi B+ is having a GPU on board. The GPU model is Broadcom BCM2835. It can support 1080p30 H.264 high-profile decode. So for this research it is quite ideal and cheap.

Desrochers and Paradis and Weaver [1] wrote in his paper that for integrated GPU, is having no way to intercept the input voltage. So they introduced SmallGPU2 as an OpenCL ray-tracer. I decide to use this benchmark to test the GPU performance on the board, because I am having this paper’s results as a comparison.

GPU is kind of new for study of the energy consuming, even it is using nearly the same energy as CPU. But I think more effort should be put on the study on GPU, for its multi-core structure can be easily saving a lot of power.

Abe Sasaki Peres Inoue Murakami and Kato [2] analysis that system energy can be reduced 28% with decreasing 1% performance by modifying the GPU, and it is trivial for CPU modifying for energy reduction.

Y. Jiao, H. Lin, P. Balaji, W. Feng [3] has investigate that energy saving mechanisms on GPU is totally different from CPU. They has used three different applications with various degrees of compute and memory intensiveness. They have done similar work. I would be using their work as comparison.

[1]S. Desrochers and C. Paradis and V. Weaver. ”The first benchmark we look at is SmallptGPU2, an OpenCL ray-tracer.” MEMSYS chapter III F section, p 4, 2016.

[2]Y. Abe H. Sasaki M. Peres K Inoue K. Murakami and S. Kato. “Our analysis on a real system discloses that system energy can be reduced by 28% retaining a decrease in performance within 1% by controlling the voltage and frequency levels of GPUs. We show that energy savings can be achieved when GPU core and memory clock frequencies are appropriately scaled considering the workload characteristics. Another interesting finding is that voltage and frequency scaling of CPUs is trivial for total system energy reduction, and even should not be applied in state-of-the-art GPU-accelerated systems.” Usenix abstract 2012.

[3] Y. Jiao, H. Lin, P. Balaji, W. Feng “In this paper, we systematically characterize the power and energy efficiency of GPU computing. Specifically, using three different applications with various degrees of compute and memory intensiveness, we investigate the correlation between power consumption and different computational patterns under various voltage and frequency levels. Our study revealed that energy saving mechanisms on GPUs behave considerably different than CPUs.” Green Computing and Communications (GreenCom), 2010 IEEE/ACM Int'l Conference on & Int'l Conference on Cyber, Physical and Social Computing (CPSCom) Abstract 18-20 Dec. 2010

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Raspberry pi B+

GPU: Broadcom VideoCore IV GPU

Broadcom BCM2835, a System-on-Chip that contains an ARM1176JZFS with floating point, running at 700MHz, and a Videocore 4 GPU. The GPU provides Open GL ES 2.0, hardware-accelerated OpenVG, and 1080p30 H.264 high-profile decode and is capable of 1Gpixel/s, 1.5Gtexel/s or 24 GFLOPs of general purpose compute.

## Reference:

### Power and Performance Analysis of GPU-Accelerated Systems

Abstract:

Our analysis on a real system discloses that system energy can be reduced by 28% retaining a decrease in performance within 1% by controlling the voltage and frequency levels of GPUs. We show that energy savings can be achieved when GPU core and memory clock frequencies are appropriately scaled considering the workload characteristics. Another interesting finding is that voltage and frequency scaling of CPUs is trivial for total system energy reduction, and even should not be applied in state-of-the-art GPU-accelerated systems.

## A validation of DRAM RAPL Power Measurements

Selecting benchmark for GPU.

Introducing the difficulty that meets when deal with integrated GPU. There is no way to intercept the input voltages. The first benchmark we look at is SmallptGPU2 [27], an OpenCL ray-tracer. We use Beignet [28] which is an OpenCL implementation for the Intel HD series of integrated GPUs. We use the default ray-trace setup, ending after 25s of tracing.

F. GPU Benchmarks