Master Thesis

GPU energy efficiency

An analysis of energy consumption, usage patterns and energy saving strategies

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"I am the master of my fate, I am the captain of my soul"

from Invictus, by William Ernest Henley

Abstract

Here goes the abstract of this thesis.

To ...

Acknowledgements

TODO

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List of Figures

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Acronyms

DVFS Dynamic Voltage and Frequency Scaling. vi, 4

GPU Graphics Processing Unit. i, 3, 4

SMI System Management Interface. vi, 3

1

Introduction

1.1 Context

TODO

1.2 Objective

TODO

1.3 Research Question

TODO

1.4 Research Method

This section describes the research method that was used.

1.4.1 Literature Study

In this section we first provide a description of the process by which literature was collected for the purpose of this study to ensure its replicability.

1.4.1.1 Search

TODO

Snowballing To gather more relevant literature the snowballing technique was used, which is the process of gathering additional literature from the references of a paper.

Application of Selection Criteria   TODO

1.4.1.2   Data Extraction

TODO

1.4.1.3   Data Synthesis

TODO

2

Background

This chapter outlines some of the research and other resources that are relevant to the topic of Graphics Processing Unit (GPU) energy conservation.

2.1 Energy Consumption

This section outlines some of the work that has been done to measure and predict energy consumption.

2.1.1 Measuring

Measuring live energy consumption is an important aspect of many power saving strategies. There exist tools that can perform these types of measurement, the most important of which are outlined in this section.

2.1.1.1 NVIDIA System Management Interface

NVIDIA's System Management Interface (SMI) tool is a command line utility that is able to query the GPU device state [3]. Support is limited to NVIDIA GPUs. What makes this tool useful to this research is the fact that it can retrieve the current power consumption from the GPU as it is running and that it can output this information to the console, which makes it possible to easily integrate the output programmatically.

2.1.2 Statistical Analysis and Prediction

Ma and Zhong [2] developed a method to statistically analyze and model the power consumption of a mainstream GPU. To achieve this they make use of the fact that there exists an innate coupling among the power consumption characteristics, runtime performance and

dynamic workloads. They found that their model is capable of robustly and accurately predicting the power consumption of a target GPU.

Chen et al. [1] TODO

2.2   Usage Patterns

TODO

2.3   Energy Saving Strategies

TODO

2.3.1   Dynamic Voltage and Frequency Scaling

Dynamic Voltage and Frequency Scaling (DVFS) is a technique that

3

Usage Patterns

TODO

4

Energy Saving Strategies

TODO

5

Dynamic Energy Saving

TODO

6

Discussions

TODO

7

Conclusion

TODO

Appendix A

TODO

References

[1] Jianmin Chen et al. "Statistical GPU power analysis using tree-based methods". In: *2011 International Green Computing Conference and Workshops, IGCC 2011*. 2011. ISBN: 9781457712203. DOI: `10.1109/IGCC.2011.6008582`.

[2] Xiaohan Ma and Lin Zhong. "Statistical Power Consumption Analysis and Modeling for GPU-based Computing". In: *Proceedings of the SOSP Workshop on Power Aware Computing and Systems (HotPower '09)* (2009), None. URL: `https://www.yecl.org/publications/ma09hotpower.pdf%20http://www.sigops.org/sosp/sosp09/hotpower.html`.

[3] NVIDIA. *NVIDIA System Management Interface | NVIDIA Developer*. URL: `https://developer.nvidia.com/nvidia-system-management-interface` (visited on 07/18/2020).

Statement of Originality

This document is written by Student Quincy Bakker who declares to take full responsibility for the contents of this document.

I declare that the text and the work presented in this document are original and that no sources other than those mentioned in the text and its references have been used in creating it.

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