Impact of Algorithms on Green Computing

Bhavana Narain
Dr.CV Raman University,
Kota, Bilaspur (C.G.), India

Sanjay Kumar
Department of Computer Science Pt. Ravishankar Shukla University, Raipur (C.G.) 492010, India

ABSTRACT

In computer science, the analysis of algorithms is the determination of the number of resources (such as time and storage) necessary to execute them. Most algorithms are designed to work with inputs of arbitrary length. Usually the efficiency or running time of an algorithm is stated as a function relating the input length to the number of steps (time complexity) or storage locations (space complexity). As the efficiency of algorithm increases number of steps involved in computation and storage requirement will reduce both of these will result in saving of electrical power and hence will contribute to green computing. In this paper various algorithms are discussed which can help in power saving and therefore will contribute to green computing. In this paper we have reviewed various algorithms for computing energy consumption on green computing.

General Terms

Algorithmic efficiency

Keywords

Green computing; Algorithm

1. INTRODUCTION

Green Computing initiatives are to reduce the environmental impacts of Global warming by reducing the use of hazardous materials, maximizing energy efficiency during the product's lifetime, and promoting the recyclability or biodegradability of defunct products. In computer science,, efficiency is used to describe properties of an algorithm relating to how much of various types of resources it consumes. Algorithmic efficiency can be thought of as analogous to engineering productivity for a repeating or continuous process, where the goal is to reduce resource consumption, including time to completion, to some acceptable, optimal level. The efficiency of algorithms has an impact on the amount of computer resources required for any given computing function and there are many efficiency trade-offs in writing programs. Algorithm changes, such as switching from a slow (e.g. linear) search algorithm to a fast (e.g. hashed or indexed) search algorithm can reduce resource usage for a given task from substantially to close to zero. Energy consumption has become one of the major issues for modern embedded systems. Initially, power saving approaches mainly focused on dynamic power dissipation, while neglecting the static (leakage) power consumption. However, technology improvements resulted in a case where static power dissipation increasingly dominates. Addressing this issue, hardware vendors have equipped modern processors with several sleep states.

2. IMPLICATIONS FOR ALGORITHMIC EFFICIENCY

According to a report published in September 2008, "Total power used by information technology equipment in data centers represented about 0.5% of world electricity consumption in 2005. When cooling and auxiliary infrastructure are included, that figure is about 1%. The total data center power demand in 2005 is equivalent (in capacity terms) to about seventeen 1000 MW power plants for the world" [1].

A recently established consortium of leading Information and Communications Technology (ICT) industry, academic and non-governmental research experts, has set itself the mission of reducing reduce energy consumption per user by a factor of 1000 from current levels"[2][3].

The genuine economic benefits of an optimized algorithm are, in any case, that more processing can be done for the same cost or that useful results can be shown in a more timely manner and ultimately, acted upon sooner [4].

3. CRITICISM OF THE CURRENT STATE OF PROGRAMMING

Reliance on Moore's law to solve inefficiencies has increased the problem. Alternative' to Moore's law stated as follows: Software efficiency halves every 18 months, compensating Moore's Law He goes on to state, In ubiquitous systems, dividing the instructions executed can double the battery life and big data sets bring big opportunities for better software and algorithms: Reducing the number of operations from N x N to N x log(N) has a dramatic effect when N is large... for N = 30 billion, this change is as good as 50 years of technology improvements [5].For algorithms executing in a "managed code" environment (such as the .Net framework platform), there are many issues that impinge on performance. These [6][7][8] are links to three of them in the Microsoft .Net environment. The following competitions invite entries for the best algorithms based on some arbitrary criteria decided by the judges [9].

4. ALGORITHMS AND SYSTEMS FOR POWER EFFICIENCY

4.1 Slack Reduction Algorithm (SRA) – Slack Reduction Algorithm Tasks with slack are executed at a minor frequency. It adjust the operation frequency of the cores during execution of a collection of tasks (in which many dense linear algebra algorithms can be decomposed) with a very different approach to save energy. A power-aware simulator, in charge of scheduling the execution of tasks to processor cores, is employed to evaluate the performance benefits of these power-control policies for two reference algorithms for the LU factorization, a key operation for the solution of linear systems of equations. The results from this procedure are modulated by an energy-aware simulator, which is in charge of scheduling/mapping the execution of these tasks to the cores, leveraging dynamic frequency voltage scaling featured by current technology [10].

4.2 Integer-bit power allocation algorithm

The Hughes–Hartog algorithm is an optimal loading algorithm which achieves the solution by adding one bit at a time to the channel requiring the smallest additional power to increase its rate. Whereas this technique can be used to solve both data rate and margin maximization, the algorithm requires an intensive amount of sorting and converges very slowly in practical DMT scenarios . A practical discrete multitone transceiver loading algorithm attempts to maximize the subchannel SNR's rather than the margin and again relies on rounding. Whereas this is a different criterion for loading, the resulting allocation should be extremely close if not identical. A new loading algorithm for discrete multitone transmission show improvement of overall SNR compared toA practical discrete multitone transceiver loading algorithm as well as some reduction in complexity. A practical discrete multitone transceiver loading algorithm uses a modest amount of sorting to subtract or add bits one at a time, which may be expensive if the initial part of the algorithm is too far from the target rate. The overall complexity of the algorithm is dominated by searches and additions, but the operation count will typically be on the same order as the margin algorithm. It is for discrete multitone modulation. Using efficient lookup table searches and a Lagrange-multiplier bisection search, this algorithm converges faster to the optimal solution than existing techniques and can replace the use of suboptimal methods because of its low computational complexity [11].

4.3 duEDF algorithm -

When only the CPU energy is considered, duEDF algorithm achieves higher energy saving over the non-DVS scheduling and has much lower complexity compared to the existing algorithmlpSEH. When the system energy (CPU energy + device energy) is considered, the duSYS and duSYS PC algorithms use a combination of optimal speed setting and limited preemption. For the case when the CPU power and device power are comparable, duSYS and duSYS PC achieve large energy savings compared to the CPU-energy efficient algorithm duEDF and over the non-DVS scheduling algorithm. If the device power is large compared to the CPU power, then DVS scheme does not result in lowest energy. Now if the devices in system operate at multiple voltage/frequency levels, the device power can be broken up into the dynamic part which is scalable and the static part which is not scalable. While this would change the system-level energy curve, the convexity property would still hold, and there would still be an optimal scaling factor. Various dynamic task scheduling algorithms are considered to determine the speed setting of both the CPU and the device for minimum system-level energy consumption. [12].

4.4 Computation and Transmission Rate Based Algorithm (CTRB)

In order to realize the digital ecosystems and the green IT technologies, it is difficult to reduce the total power consumption of computers and networks. The EPCLB algorithm is used to select one of servers so that the total power consumption of the servers can be reduced for general types of applications. In the EPCLB algorithm, a server whose TPCL is minimum is selected for a new request in a set of servers. The TPCL shows how much electric power a server has to consume to perform up all the computation and transmission processes at time . Therefore, in the EPCLB algorithm, a load balancer has to collect current status and calculate the TPCL of every server to select a server for a request each time the load balancer receives a new request. Here, if the number of clients concurrently performed is increased, the computation and communication overheads to estimate the TPCL of servers are increased on a load balancer. In addition, the status of each server might be changed during the estimation process due to the communication delay between a load balancer and servers. Hence, in the EPCLB algorithm, it is difficult to correctly estimate the TPCL of servers and the load balancer might be bottleneck of the system in real environments. The CTRB algorithm is used to select a server in a set of servers so that the total power consumption of servers and the overhead of a load balancer can be reduced. In the CTRB algorithm, a server in a set of servers is selected for a new request without considering the TPCL of servers. Hence, a load balancer does not need to collect current status of every server in a server set S each time the load balancer receives a new request from a client. As the result, the overhead of a load balancer to select a server for each request can be reduced. We evaluate the CTRB algorithm in terms of the total power consumption of servers, the elapse time to terminate the every request, and the total number of messages between a load balancer and servers compared with the RR and EPCLB algorithms. The difference of the elapse time among the CTRB, EPCLB, and RR algorithms is neglectable. In the CTRB and EPCLB algorithms, 12% and 35% of the total power consumption can be reduced, respectively, compared with the RR algorithm. The total power consumption can be more reduced in the EPCLB algorithm than the CTRB algorithm. However, more number of messages have to be exchanged between a load balancer and servers to forward a request to a server in the EPCLB algorithm than the CTRB algorithm. Hence, in real environments, the estimation of the TPCL in the EPCLB algorithm might not be correct and the load balancer might be bottleneck of the system. On the other hand, the number of messages to be exchanged between a load balancer and servers can be more reduced in the CTRB algorithm than EPCLB algorithm. Therefore, the CTRB algorithm is simpler and more useful than the EPCLB and RR algorithms for real environments [13].

5. DISCUSSION

- SRA show significant energy gains for two key dense linear algebra operations: the Cholesky and QR factorizations.
- Integer-bit constellations, can be used for systems containing non integer-bit constellations. It will work for any set of discrete points on the rate-SNR curve pro-vided the function is convex
- When only the CPU energy is considered, duEDF achieves higher energy saving (up to 45% over the non-DVS scheduling).
- When the system energy (CPU energy + device energy) is considered duSYS and duSYS PC use a combination of optimal speed setting and limited preemption.

- In the CTRB algorithm, a server in a set of servers is selected for a new request without considering the TPCL of servers. Hence, a load balancer does not need to collect current status of every server in a server set S each time the load balancer receives a new request from a client. As the result, the overhead of a load balancer to select a server for each request can be reduced.

6. CONCLUSIONS

Green Technology is the movement towards applying technology for environmental friendly and cost-effective use of power and production. Through various algorithm efforts has been made to reduce power consumption in every part of computer. Low power consumption will contribute in Green Technology.

7. ACKNOWLEDGMENTS

I thank my guide Dr. Sanjay Kumar and CGCOST

8. REFERENCES

[1] "Worldwide electricity used in data centers". Iop.org. Retrieved 2011-12- 14.

[2] "Rechnology News: Green Tech: Harvard Physicist Sets ecord Straight on Internet Carbon Study". Technewsworld.com. Retrieved 2011-12-14T.

[3] "About Us". Green Touch. Retrieved 2011-12-14.

[4] "Innovators: Efficiency Matters - March April 2007 - Sierra Magazine". Sierra Club. Retrieved 2011-12-14.

[5] www.cs.bris.ac.uk/~dave/iee.pdf

[6] msdn.microsoft.com/en-us/library/ms973852

[7] msdn.microsoft.com/en-us/library/ff647790.aspx

[8] www.dotnetperls.com/optimization

[9] Fagone, Jason(2010-11-29)."Teen Mathletes Do Battle at Algorithm Olympics".

[10] Alonso, Pedro, "Improving power efficiency of dense linear algebra algorithms on multi-core processors via slack control", IC on High Performance Computing and Simulation (HPCS), 2011,PP 463- 470.

[11] Krongold, Brian Scott, "Computationally efficient optimal power allocation algorithms for multicarrier communication systems", Communications, IEEE Transactions on Jan 2000, pp 23-27.

[12] Jianli zhuo and chaitali chakrabarti "Energy-Efficient Dynamic Task Scheduling Algorithms for DVS Systems", ACM Journal Name, Vol. V, No. N, Month 20YY, Pages 1– 22.

[13] Tomoya Enokido, Ailixier Aikebaier, Makoto Takizawa,"Computation and Transmission Rate Based Algorithm for Reducing the Total Power Consumption", Journal of Wireless Mobile Networks, Ubiquitous Computing ,and Dependable Applications, volume: 2, number: 2, pp. 1-18.