INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
(Volume2, Issue6)
Available online at: www.Ijariit.com

Offloading In Mobile Cloud Computing By Exception Maximization Algorithm

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Abstract*— *Offloading in mobile cloud computing by exception maximization algorithm is the idea to augment execution through migrating heavy computation from mobile devices to resourceful cloud servers and then receive the results from them via wireless networks. Offloading is an effective way to overcome the resources and functionalities constraints of the mobile devices since it can release them from intensive processing and increase performance of the mobile applications, in terms of response time. Offloading brings many potential benefits, such as energy saving, performance improvement, reliability improvement, ease for the software developers and better exploitation of contextual information. Parameters about method transitions, response times, and cost and energy consumptions are dynamically re-estimated at runtime during application executions.

Keywords*— *Cost, Energy, Mobile Offloading, Cloud.

I. INTRODUCTION

Today, emerging smartphone and tablet PC technologies have redefined personal computing in our everyday lives. Some mobile devices, such as smart phones, iPad and Kindle, have replaced PC as the most widely used computing devices in terms of Internet usage statistics. These mobile devices have become so popular due to the better ergonomic interface and portability over conventional laptops. Smartphones are a category of mobile phones which are "smart" (i.e., more capable) when
compared to traditional mobile phones. Smartphones are targeted to address the need for a pocket PC in addition to a phone. As a result they offer many features which are not usually associated with mobile phones, such as the ability to run downloaded software applications, web browsing capabilities, etc. Figure 1 contrasts the difference in style of a traditional mobile phone and a smartphone with regard to their appearance. Two of the most obvious differences are the larger screen and keyboard of the smartphone – as interaction is no longer limited to browsing menus, dialling phone numbers, storing/retrieving phone book entries, entering/reading short messages, and playing simple built-in standalone games. These are some key features of smartphones which make it "smarter" than traditional mobile phones.
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However, the full potential for smartphones and tablet PCs may be constrained by certain technical limits such as battery endurance, computational performance, and portability. Modern mobile applications own more powerful functions but need larger computation and faster frame rate, which consume more battery energy. Over the years, battery's energy density has not improved as significantly as semiconductor technologies. Unlike conventional cell phones, for which a single charge may last for several days, today's smartphones and other mobile devices barely sustain normal usage for a day without being charged.

Hence, there are two ways to prolong battery endurance: one that increases the energy capacity, i.e., increasing the battery size, and one that reduces power consumption rate. Increasing the battery size leads to the increase in manufacturing cost as well. Also the device size is virtually fixed for ergonomic consideration; we are very likely to trade battery endurance for computational performance, or vice versa, when designing a smartphone or a tablet PC.

That is, we either make our device superior in performance but running out of battery sooner, or make them withstand longer at potentially lower performance. With the device size assumed to be fixed, we may trade-off battery endurance for computational performance as part of designing a smartphone or a tablet PC.

The process of computation on a mobile device is known as mobile computing. Nomadic computing, another name for mobile computing, is the use of portable computing devices (such as laptop and handheld computers) in conjunction with mobile communications technologies to enable users to access the Internet and data on their home or work computers from anywhere in the world. People using such a system are sometimes referred to as *technomads*, and their ability to use that system as *nomadicity*. The mobile computing paradigm has seen tremendous advancements in recent times. Smartphones have emerged as a type of mobile device providing "all-in-one" convenience by integrating traditional mobile phone functionality and the functionality of handheld computers. Various models of smartphones have been released catering to the various demands of mobile users. Today smartphones offer PC-like functionality to end users allowing them to check their e-mail, maintain calendars, browse the internet, watch videos, play music, etc.

Cloud Computing provides us means by which we can access the applications as utilities over the internet. It allows us to create, configure, and customize the business applications online.

The term Cloud refers to a Network or Internet**.** It goes back to the days of flowcharts and presentations that would represent the infrastructure of the Internet as nothing but a puffy, white cumulus cloud, accepting connections and doling out information as it floats. In other words, we can say that Cloud is something, which is present at remote location.

1.1 OFFLOADING

Offloading in its simple terms can be defined as the mechanism of partitioning an application into off loadable and non off loadable sections considering various parameters and then remotely executing the offlloadble sections.[22]Offloading has become a promising technique to enhance the capabilities of resource constrained mobile devices by allowing smartphones to offload computationally intensive workload to servers. Although computational offloading, which emerged around 1970s, is not a brand new concept, its potential has never been so extensively explored until advanced wireless communication and high-speed Internet can sufficiently support it without significantly degrading the user experience. Cloud computing, which was a different approach to explore the potential of ubiquitous Internet connectivity, facilitates and inspires innovations on computational offloading scheme. Offloading computation from resource constrained devices has been an area of focus for researchers. This aim of this thesis project is to improve the perceived performance of mobile devices by utilizing the broadband wireless connectivity of these devices. Offloading might benefit in terms of execution speed as cloud is a resource rich platform, but the available network bandwidth might be a spoilsport while transferring the data from mobile to cloud for offloading.

1.2 METHODS OF OFFLOADING

The main operation in any mobile cloud would be the offloading of jobs that take place from the resource constrained mobile device to the cloud. Because of issues such as the physical distance separating the mobile device and the cloud and the heterogeneity of the underlying systems, different research has tackled this in a variety of ways.

1.2.1 STATIC OFFLOADING

In static offloading application is partitioned during development. In static environment, parameters such as data size and execution time which acts as deciding factor for offloading are known beforehand. However, it is difficult to know the correct execution time before the actual execution takes place and the inaccurate data can result into inefficient offloading result.

1.2.2 DYNAMIC OFFLOADING

Dynamic network environment means changing connection status and bandwidth that affect the process of offloading. By the term dynamic offloading we mean that the modules may be transferred for execution onto cloud when the application is running.

II. LITERATURE REVIEW

Li.Z, Wang.C, Xu.R[1] presents an offloading scheme based on profiling information about computation time and data sharing at the level of procedure calls. A cost graph is constructed and a branch-and-bound algorithm is applied to minimize the total energy consumption of computation and the total data communication cost. However, the authors did not show the experiment results in a dynamic environment such as network disconnection and bandwidth changes (high to low bandwidth).

Wang.C, Li.Z [2] presents a computation offloading scheme on mobile devices and proposes a polynomial time algorithm to find an optimal program partition. Both the static information and the run-time information were used. The proposed scheme partitioned a program into the distributed subprograms (which run on a device and a server) by producing a program abstraction. In this case, all physical memory references were mapped into the references of abstract memory locations. The program abstraction is generated at a runtime based on pointer analysis techniques. The program abstraction is divided into clusters by clustering analysis and a heuristic algorithm is applied into the clusters to find the optimal partition to minimize the execution cost of the program.

Miettinen.A, Nurminen .J[3] The authors consider energy efficiency problem. The reason behind this is that mobile devices are energy constrained and they lack sufficient resources. They provide an analysis of the critical factors affecting the energy consumption of mobile clients in cloud computing. Further, they present measurements about the central characteristics of contemporary mobile handheld devices that define the basic balance between local and remote computing. They also describe a concrete example, which demonstrates energy savings. They analyzed the energy consumption of mobile clients in cloud computing. There are many factors that make cloud computing an attractive technology, but energy consumption is a fundamental criterion for battery powered devices and needs to be carefully considered for all mobile cloud computing scenarios. While energy can be a challenge for mobile cloud computing, it is also as an opportunity. Mobile cloud computing is therefore a fruitful area for further research.

Kumar.K, Lu.Y[4] suggest a program partitioning based on the estimation of the energy consumption (communication energy and computation energy) before the program execution. The optimal program partitioning for offloading is calculated based on the trade-off between the communication and computation costs. The communication cost depends on the size of transmitted data and the network bandwidth, whereas the computation cost is impacted by the computation time. However, information such as the communication requirements or/and the computation workload may change in different execution instances. Thus, optimal decisions of a program partitioning must be made at a runtime dynamically.

Carroll.A, Heiser.G [5] Good energy management requires a good understanding of where and how the energy is used. They derive an overall energy model of the device as a function of the main usage scenarios. This should provide a good basis for focusing future energy-management research for mobile devices.

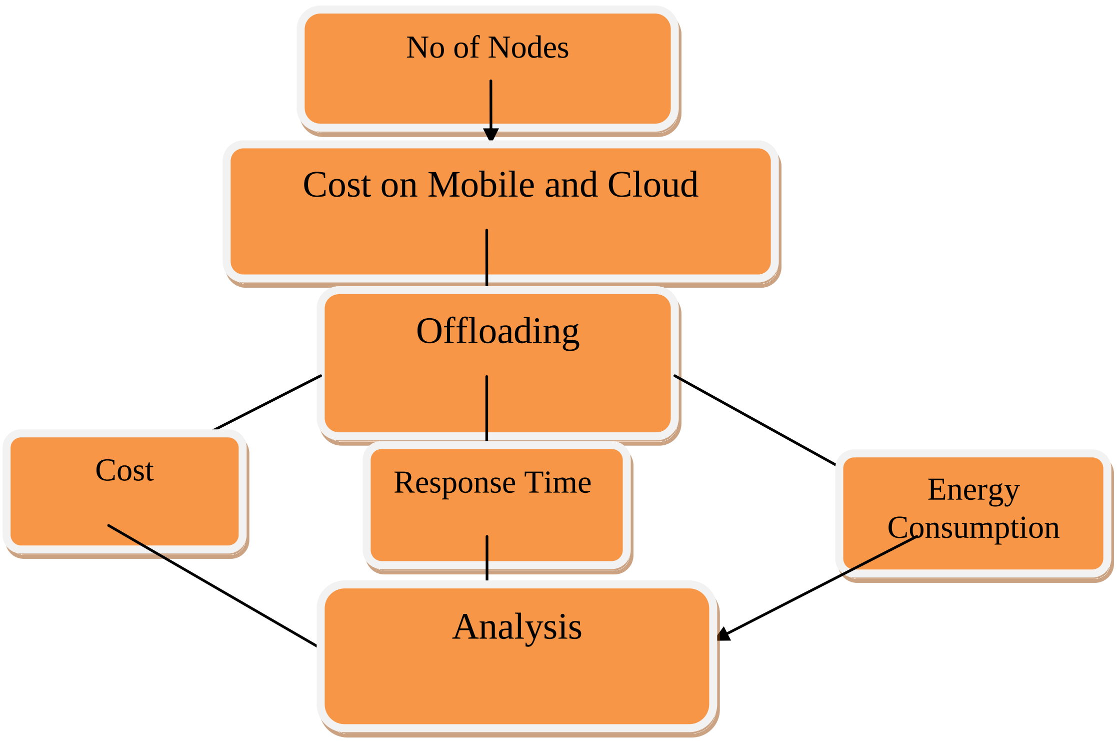
B. Chun, S. Ihm [6] Clone Cloud system automatically transforms mobile applications to benefit from the cloud. The system is a flexible application partition and execution runtime that allows unmodified mobile applications running in an application level virtual machine to cleanly off load part of their execution from mobile devices onto device clones operating in a computational cloud. Clone Cloud is a combination of static analysis and dynamic profiling. It partition applications automatically at a fine granularity while reducing execution time and energy use for a target computation and communication environment. At runtime, the application partitioning is enhanced by migrating a thread from the mobile device at a chosen point to the clone in the cloud, executing there for the remaining part of the partition, and reintegrating the migrated thread back to the mobile device. Clone Cloud can adapt application partitioning to various environments, and can help few applications achieve as much as a execution speed up and a decrease of energy consumption on the mobile device. Clone Cloud brings the power of Cloud Computing to your smartphones. History based profiling is used. But real Network and device conditions cannot be generalized. Pre-calculated partitions cannot cover all the offloading scenarios.

H. Dinh,C. Lee [7] give a survey of MCC, which helps general readers have an overview of the MCC including the definition, architecture, and applications.
The authors list several research issues in MCC, which are related to the mobile communication and Cloud Computing such as issues in mobile communication side and in computing side**.** They tend to focus on the implementation of optimization techniques such as virtualization and consolidation on evaluating cloud computing data centres aspects that directly or indirectly have impact on energy issues.

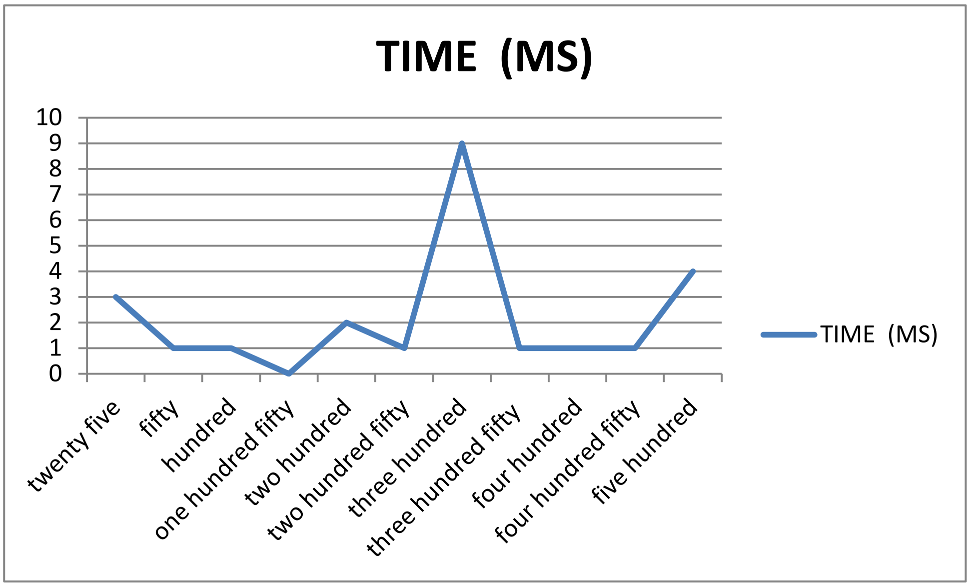
Calheiros.R, R.Ranjan [8] proposes Cloud Sim: an extensible simulation toolkit that enables modelling and simulation of Cloud computing systems and application provisioning environments. The Cloud Sim toolkit supports both system and behavior modelling of Cloud system components such as data centres, virtual machines (VMs) and resource provisioning policies. It is a suitable research tool that can handle the complexities arising from simulated environments.

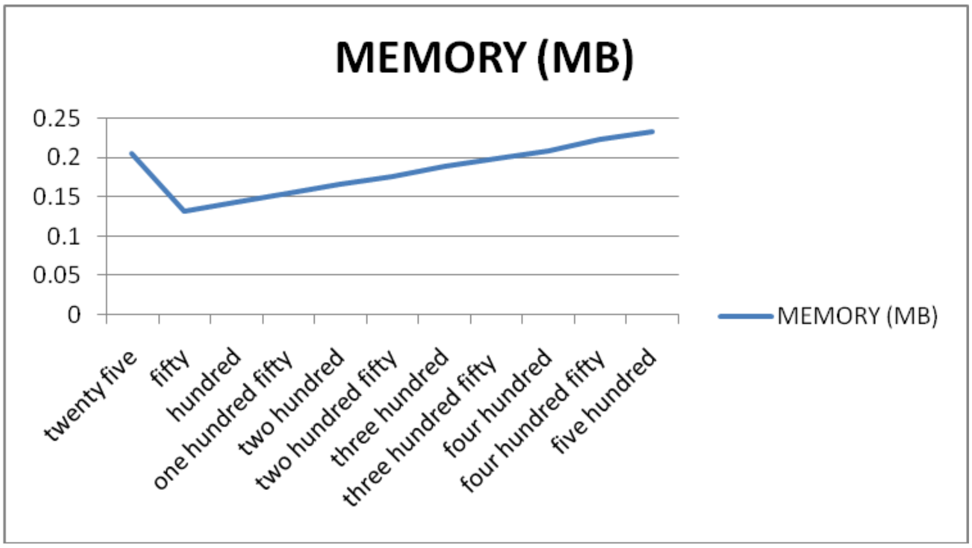
III. **PROPOSED WORK**

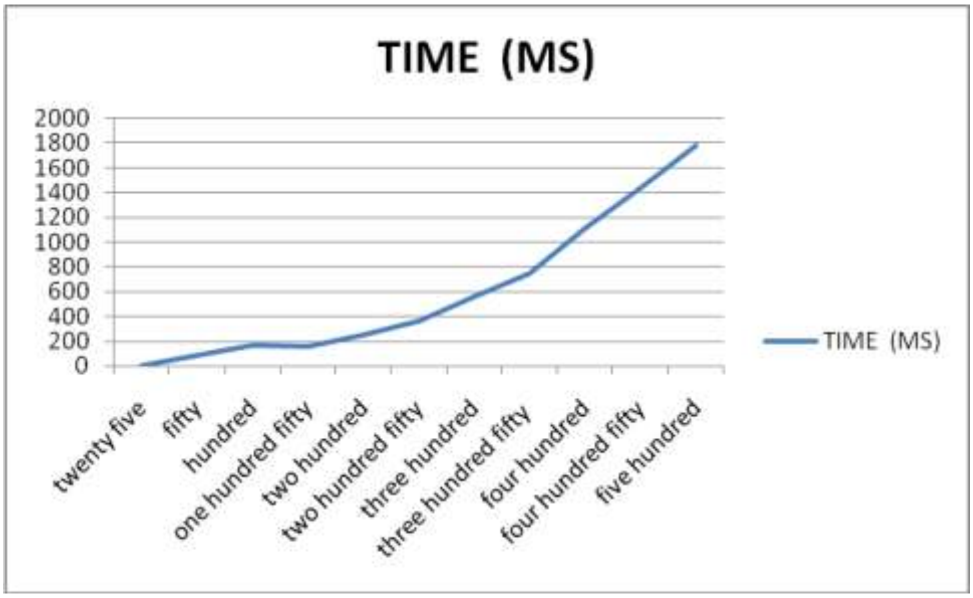
The main idea is to augment execution through migrating heavy computation from mobile devices to resourceful cloud servers and then receive the results from them via wireless networks. Offloading is an effective way to overcome the resources and functionalities constraints of the mobile devices since it can release them from intensive processing and increase performance of the mobile applications, in terms of response time. Offloading brings many potential benefits, such as energy saving, performance improvement, reliability improvement, ease for the software developers and better exploitation of contextual information. Parameters about method transitions, response times, cost and energy consumptions are dynamically re-estimated at runtime during application executions. The goal is to improve the utilization of computing resources and reduce energy consumption.



IV. RESULT ANALYSIS



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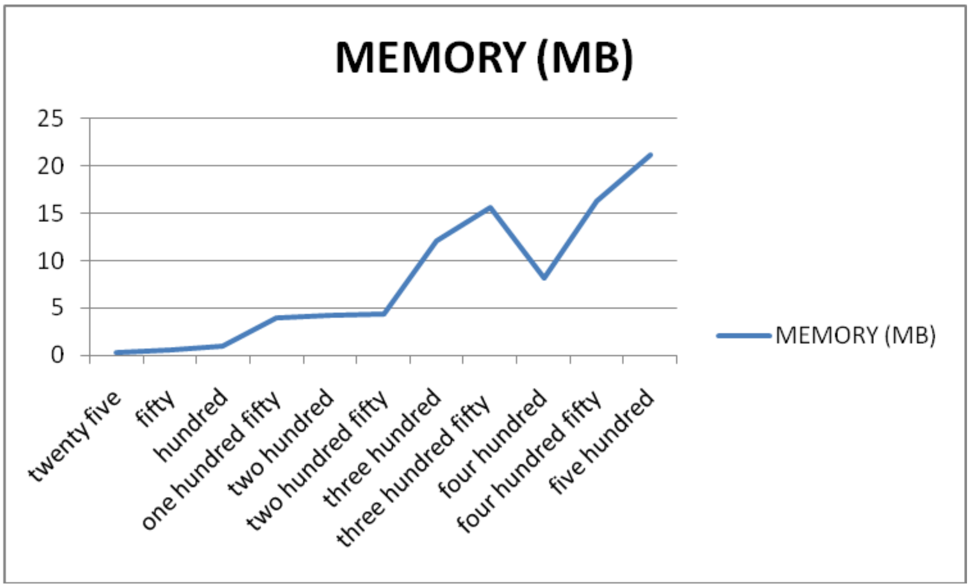
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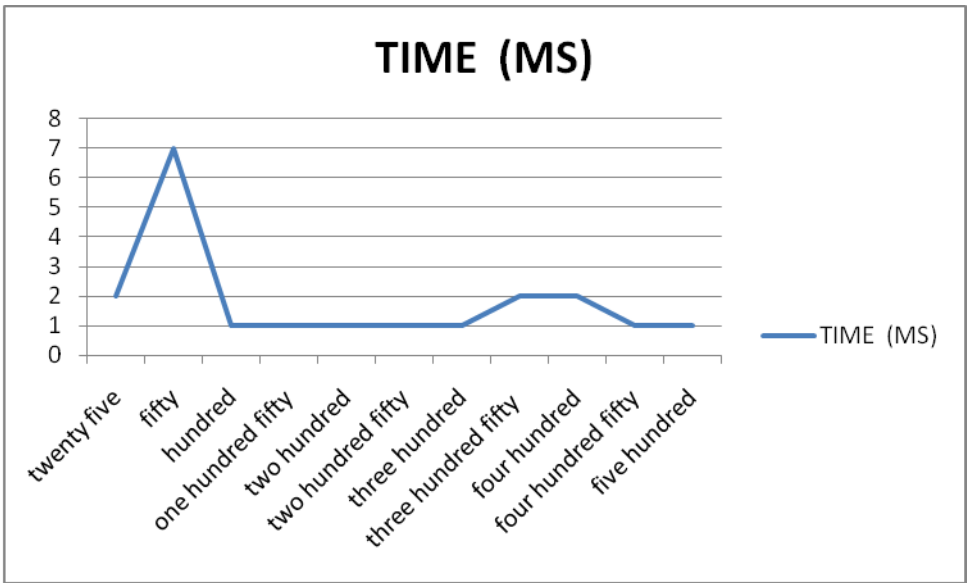
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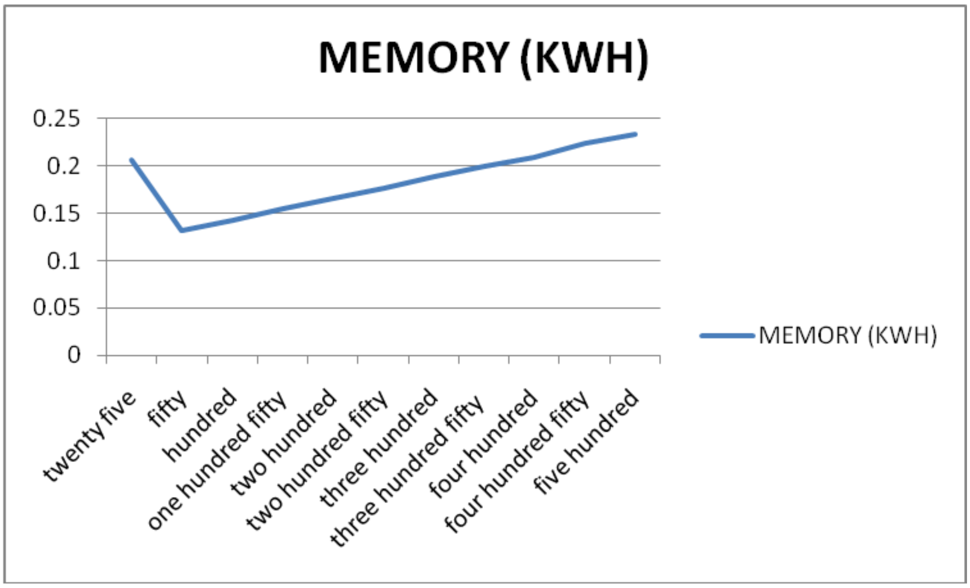
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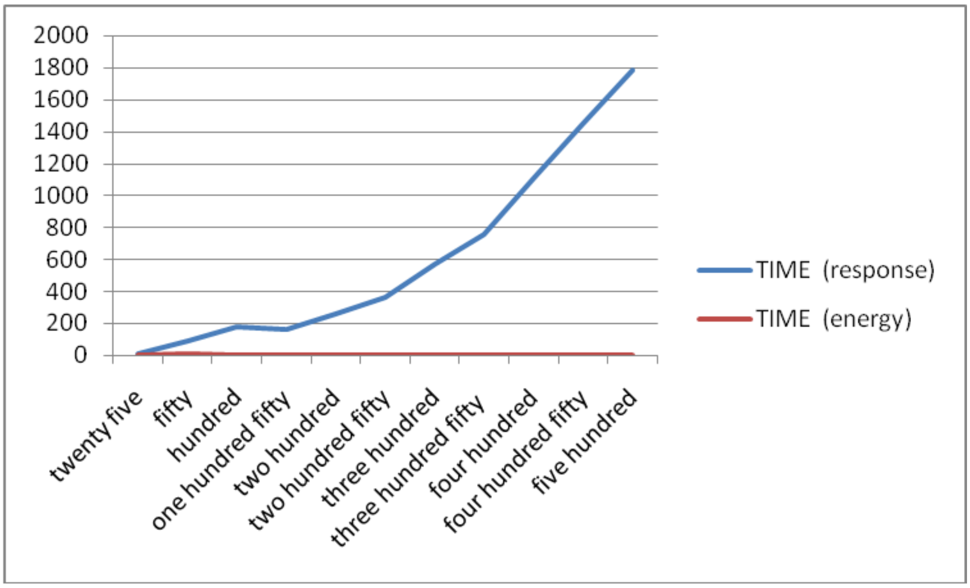
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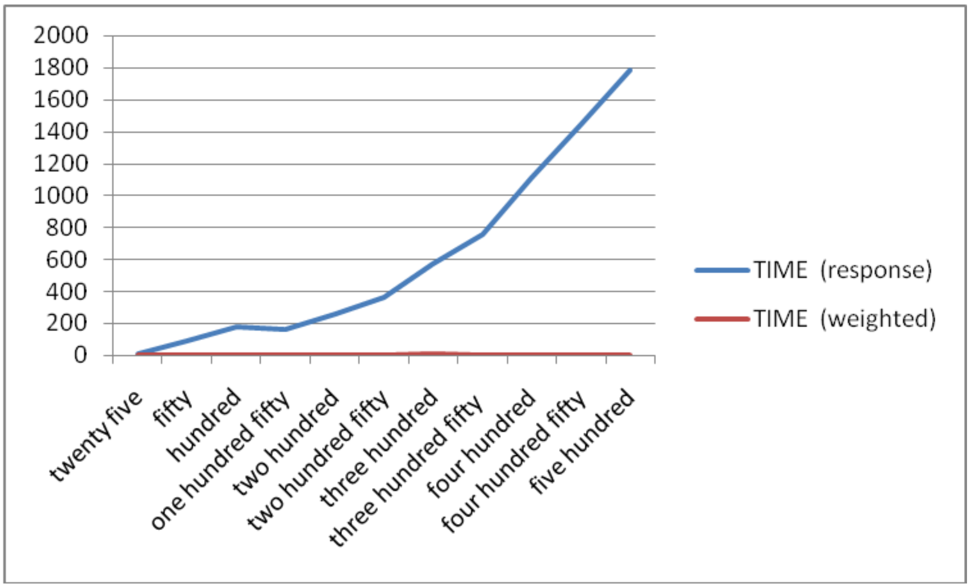
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TIME (response)
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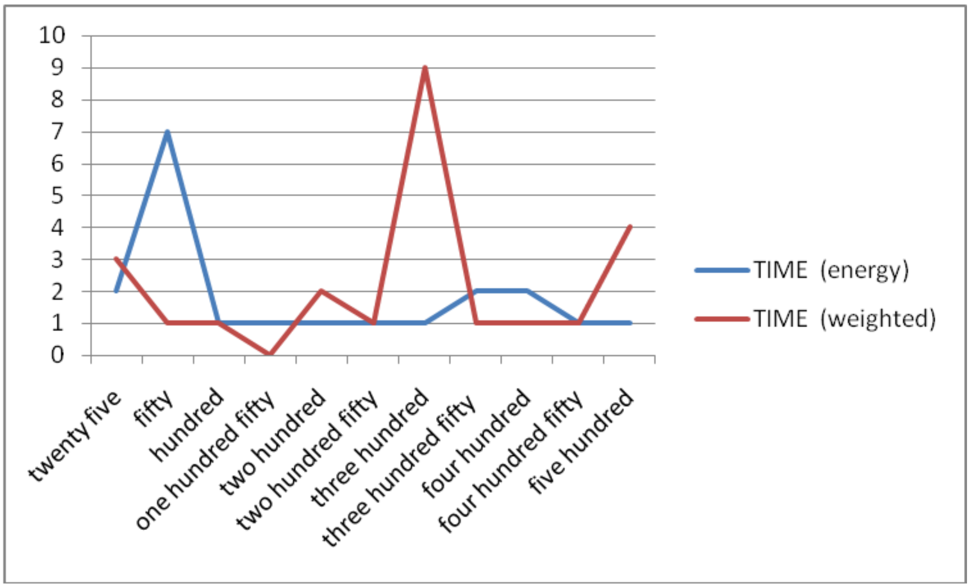
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TIME (energy)
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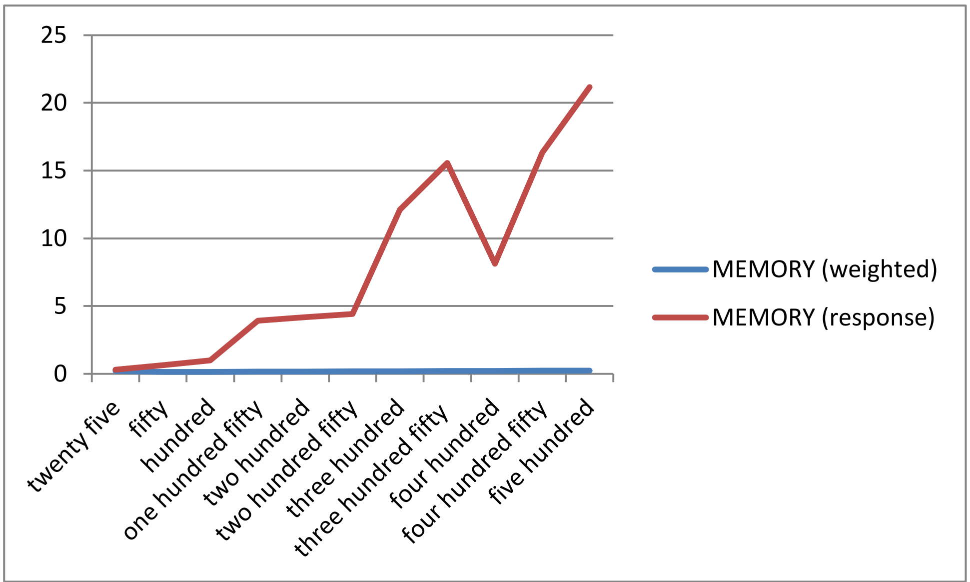
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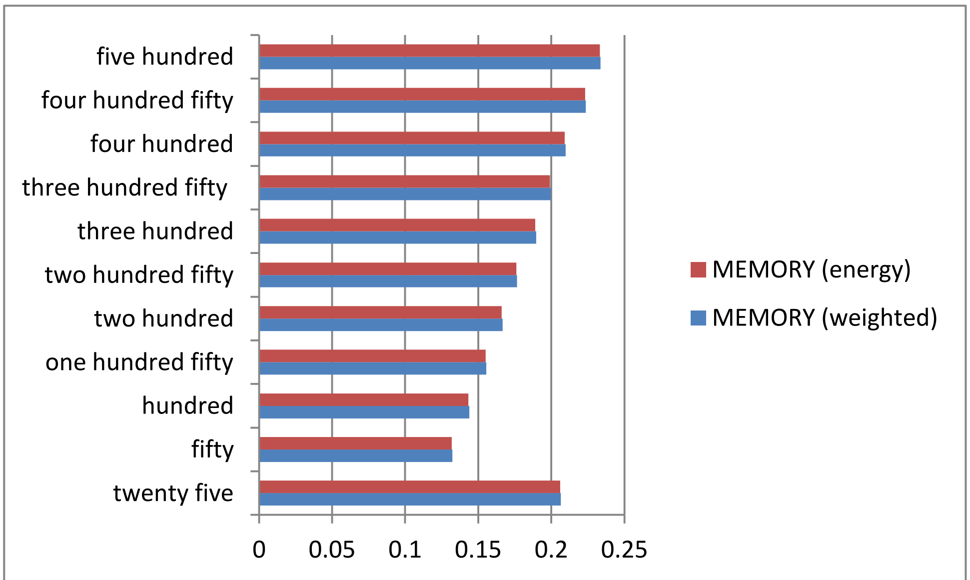
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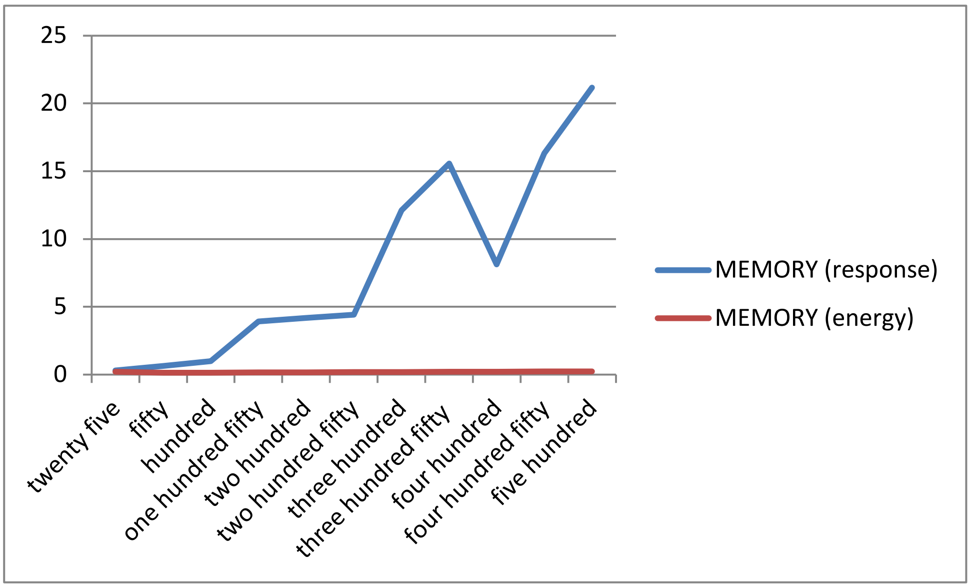

V. CONCLUSION

Several solutions have been proposed to enhance the CPU performance and to manage the disk and screen in an intelligent manner to reduce power consumption. However, these solutions require changes in the structure of mobile devices, or they require a new hardware that results in an increase of cost and may not be feasible for all mobile devices. By offloading the computational intensive part of the application which requires less communication to the rest of the application, to the cloud, a mobile device can save significant amount of battery energy and provide more responsive user experience. In this thesis, we have presented a computation offloading scheme on handheld devices. Our partition algorithm finds optimal program partitioning for given program input data. Experimental results show that our computation offloading scheme can significantly improve the performance and energy consumption on handheld devices.

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