**Android Energy Manager [or better title]**

A user friendly energy tool for Android Phones

Vikram Shanker

Carnegie Mellon University

Pittsburgh, PA, USA

vshanker@andrew.cmu.edu

Shilpa Murthy

Carnegie Mellon University

Pittsburgh, PA

shilpam@andrew.cmu.edu

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*Index Terms*—Component, formatting, style, styling, insert. *(key words)*

# Introduction *(Heading 1)*

The use of mobile devices has now permeated our everyday lives. Cellular phones and other devices are merely an extension of the self. They are used and relied upon for everyday tasks such as phone calls, emails, text message, social media, web browsing and more. As the usage of smartphones increases, the battery life of phones has began to decrease. In the days of flip phones, devices could be used for multiple days without charging. However, now, most devices don’t last more than 6-8 hours.

The source of the loss in battery life is two-fold. First, the increased usage of the cell phone will naturally cause some loss in battery life. It is unrealistic to expect that we use a device much more and still have it maintain the same battery life. Second is the rise of power-hungry mobile applications. Mobile applications are consuming increasingly more of the phone’s energy.

There are two general classes of applications that consume disproportionally large amounts of energy. The nature of some applications is such that they must use large amounts of energy. Applications such as maps that rely heavily on real-time sensor data will naturally and inevitably use more battery. Other applications, such as Facebook, run continuously in the background polling for updates or user information, unbeknownst to the user, draining battery significantly. The second class is particular instances of applications that happen to consume more energy. This can sometimes be due to a faulty launch in the application and a simple restart is enough to cure the issue. Other times, the software itself has a bug.

Distinguishing between these two cases is difficult for a computer to do given that it has no information about the baseline of how much energy the app is expected to consume. However, this information is often intuitive to the user. It is simple for the user to determine whether the app is a naturally energy intensive application or it is consuming unexpected amounts of energy. Therefore, Android Energy Manager delegates the task of determining these thresholds to the user. The choice of this approach will be discussed in future work.

# Related Work

Many research projects have taken various approaches to monitoring application energy usage. Carat, by Oliner et al. takes a black-box approach at diagnosing energy-usage. Pathak et al. took a fine-grained approach to diagnosing energy usage, and Balasubramanium et al use native instrumenting tools to measure mobile device energy consumption.

In Energy Consumption in Mobile Phones, the native Nokia Energy Profiler was used to sample the energy consumed every 250 milliseconds. The application reported consumption at 95% confidence. Obvious drawbacks to the method are that this only works on Nokia phones. Furthermore, even though the data is fine-grained and accurate, users have reported that interpreting the data presented by the application is difficult to interpret and act upon. This is because the energy profiler only estimates energy consumption device level. It does not profile at the application level.

Pathak et al take the opposite approach in Fine Grained Energy Accounting on Smartphones with Eprof. They instrument the code in order to fully understand how energy is consumed at the sub-application level. However, this method is not portable for our application since it requires the source of applications. Furthermore, to measure the energy of a new app requires work for each additional app, which does not allow for universal use.

In Carat, Oliner et all take a blackbox approach to measuring app energy consumption at the application level. The blackbox approach, which does not require knowledge about the application, allows for the app to be used universally. To diagnose energy hogs and energy bugs, the application measures system wide energy usage as well as all processes running and constructs a graph representing the data. It compares many such graphs from various devices to detect apps as energy hogs (which consume disproportionately high energy across devices) and energy bugs (a particular instance of the application is consuming more energy than others) and reports it to the user. However, Carat’s implementation fails to distinguish between applications that should use more energy and those that do not. For example, Carat detects a map application as a hog, even though, it should naturally use more power.

[Insert Application Name Here] uses various aspects of the above implementations in order to allow the user to manage the energy consumption at the application level in order to extend the device lifetime.

# Design

The App Energy monitor aims to provide users with a tool to accurately understand and control how their phones consumes energy. As such the design had to meet a few specifications.

1. The application must be work for all applications and processes on that run on an android phone.
2. The application should provide the user with the ability to easily view and understand application level energy consumption.
3. The information provided by [Insert title here] should be easily actionable by the user.
4. The application should not incur large overhead as to increase battery drain of the phone.

**A - Universal Use**

In order for the application to be effective, it must work for any application and process that runs on the mobile device. This means we must adopt a blackbox like approach as used in Carat. Approaches similar to Pathak which allows for the lowest level of measurement will not port across applications easily. Furthermore, this level of detail is not necessarily useful since most user will not understand or be able to act upon it. The blackbox is sufficient since users cannot alter the mechanisms of the application, but can only choose to run it or not run it.

**B – User Actionability**

A major drawback of many systems is that the information given by application is not understood by the user or not actionable by the user. Data that presents uncontextualized information about energy consumed in millijoules use of little use to users since most users don’t have enough knowledge to understand what the number is saying. Other times, graphs displayed provide really detailed information but again no information that provides usable information to the user. Providing the user with well-chosen information about the application that allows the user to make informed decisions is key. [Insert application name here] provides users with a simple statistic about the energy consumption and memory consumption of each application/process. Users then have the option to set thresholds based on the information presented. This will be discussed in detail in \_\_\_\_\_\_insert section\_\_\_\_\_.

**C. Actionability –**

An effective application should also be one that empowers the user to take action based on the information given. In this application, we use the idea of thresholds, derived from Carat. In Carat, if an application was using significantly more energy as compared to its peers, it was classified as a energy hog. The issue with this method was that it did not distinguish between applications that required more energy since they use more sensor input, such as a GPS or Internet Radio, versus one that doesn’t, like a game. Automatically classifying application can be very difficult. Therefore in this application, we allow the user to decide how to partition out the energy. We do this using the idea of thresholds. A user is allowed to specify a threshold power consumption for an application. Ideally, if the application exceeded that threshold, the application would be killed. This methodology poses two problems. First, it is possible that the application may use an abnormal amount of power for a short amount of time for a special process. In this event, the user would not want the application to be killed. Second, this methodology would allow application to kill application. For obvious security reasons, this is not possible in android phones. As an alternative, [Insert Application Name Here] notifies the user that an app is consuming too much power via a standard notification. The user can then either directly kill the application his or herself. Alternatively, the user can use the application to get more information before making a decision or even choose to ignore the suggestion.

Application thresholds are simply modified by the user.

Explain the choices of this paper

User defined thresholds

Simple selection

Hourly detection and user notification (android does not give access killing apps immediately + more user defined control so apps aren’t killed when they are undergoing some desired behavior)

# Measuring Energy

Cpu usage is highly proportional to energy usage.

V. Evaluation

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The subscript for the permeability of vacuum **0, and other common scientific constants, is zero with subscript formatting, not a lowercase letter “o”.

In American English, commas, semi-/colons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)

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The prefix “non” is not a word; it should be joined to the word it modifies, usually without a hyphen.

There is no period after the “et” in the Latin abbreviation “et al.”.

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