A proposal on an energy-saving policy on context based system

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Abstract

During the last decade, technology has created a new field in software development, known as pervasive computing, thanks to the improvement and extension of integrated sensors. These sensors have been successfully integrated in the daily-life of the common user, using devices like mobile phones. Those new hardware improvements gave the common developer the chance to generate new and more complete applications, which interact with the user's life with a minimum effort. However, it also meant an extra consumption of device's resources, which is translated into a extra energy consumption. The contribution of this work is to propose a new policy for energy saving applications in the framework of context-aware systems. The expected energy saving achieved through this police means to be significant both in the perception of the duration of the battery by the user and reducing the impact of these devices in the environment.

Keywords: Pervasive, eco, energy, saving

1. Introduction

Mobile devices experienced a boom after the appearance of last generations' mobile phones and tablets. The ease of development and use and the wide range of applications available for those devices, as well as an affordable price, make them a very attractive option for common users. Along with the appearance and expansion of these devices, a new business model based on mobile devices applications was originated. Through buying and selling of applications, the user can create a device as personal as he wants to, using only those applications that he considers important in his daily-life [5].

But the evolution of the hardware resources carried with it a stronger will from the developers of exploiting these resources and the users of having more accurate applications. However, these requests implied an extreme use of the rest of the device resources, meaning an exhausting use of energy [6] and, by hence, an important impact in the perception of the duration of the battery duration by the user and the CO2 indirectly released to the atmosphere [7].

In order to adapt the hardware improvements to the real demands of the user, the development of new software should make an intelligent use of resources [8], besides the potential characteristics of the device. However, Due to the new model of business created for these environments, it is not possible to force a third party developer to make an accurate use of resources. Furthermore when the field of development directly involves the use of sensors and evaluation of multiple data [4], as it happens in the development of context-aware applications.

Therefore, in this work we propose the use of a policy based system for a dynamic management of context-aware applications in mobile devices [9]. Our approach uses a separated architecture of applications (context generator and user interface) and a DEA based system to classify the effectiveness of each one [1, 2].

2. Our Approach

The main idea of this work is to change the concept of development of Context-Aware applications from a closed developed application view to a collaborative system through developers. Splitting the user's interface to the background process of determining contexts, we can evaluate the effectiveness of the context's evaluation and choose the more adequate for our purposes.

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So, the first phase is to classify the contexts generators so they can be evaluated together. A context generator can provide for different contexts and it could be evaluated both as different single contexts and a more complex one. Once we defined the context, we have to define the input/output variables to be evaluated.

This classification is done based on performance characteristics. Each context application performs one or more specific functions which can be classified according to the goal that each one of these functions is pursuing to achieve in order to solve a problem related with the user. According to these problems solved, two or more context can be classified between them as follows:

- **Similar contexts:** If two or more context pursuits similar problems, for instance, two activity recognition services which addresses different activities (the first one determines the user's physical activity like walking, sitting and laying and the other one the user's virtual activity like working, driving or travelling), these context are addressed to be in the same category or 'similar'.

- **Equivalent contexts:** In case that two or more similar contexts solve an equivalent problem but they are not exchangeable, for instance, two different activity recognition systems which solve a group of problems which are the same but include some other different activities (the first one determines the user's physical activity like walking, sitting and laying and the other one solves the same group of physical activities plus the user's virtual activity like working, driving or travelling), they are addressed to be 'intersection' or 'equivalent' contexts.

- **Exchangeable contexts:** Finally, if two different systems provide a solution for the same group of problems, for instance, two different activity recognition systems which solve exactly the same activities. In this case, these contexts are addressed to be 'equal' or 'exchangeable' contexts.

3. Context-Aware Systems

Pervasive computing technologies are based in offering 'anytime, anywhere, anyone' computing by decoupling users from devices To provide adequate service for the users, applications and services should be aware of their contexts and automatically adapt to their changing contexts-known as context-awareness.

Context is any information that can be used to characterize the situation of an entity (like the present status of people, places, things and devices in the environment). An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including location, time, activities, and the preferences of each entity.

Context-aware systems are able to use context information. A system is context-aware if it can extract, interpret and use context information and adapt its functionality to the current context of use.

One goal of context-aware systems is to acquire and utilize information on the context of a device in order to provide services that are appropriate to the particular people, place, time, event, etc.

Context-aware systems claim to be an important part of the future technologies' improvements in mobile and daily life systems. However, context-aware systems lack from a community of experienced developers in these systems and the excessive use of integrated sensors and hardware done by the existent systems and frameworks affects the evolution of these systems and their integration in devices with low hardware specifications.

One of the main problems associated with context-aware systems is the energy use of different installed applications in the device. Approaches to solve these issues are classified into hardware and software oriented solutions. Hardware solutions are based on improving the use of energy made by hardware devices and they include bigger money budgets for development of solutions. Software approaches include the better use of energy made by installed applications and the management of running installed applications in the device by third party ones (like, for instance, the Operating System).

4. Data Envelopment Analysis (DEA)

The methodology of DEA has been traditionally used to estimate the relative efficiency of a set of productive units. In recent years, other applications have been developed in which includes DEA as a possible tool for obtaining synthetic indices from partial indicators.

It is originally a nonparametric procedure that uses a linear programming technique that will allow evaluation of the relative efficiency of a set of homogeneous production units.

The main advantage of this technique is targeted to its flexibility, because it requires that all units grant the same importance to the same partial indicator. Thanks to the use of this tool for economical analysis we will be able to evaluate the relative performance of the different tasks and gives us a possible classification of suitability.
For our work, Data Envelopment Analysis (DEA) has been used as a software approach for reducing energy consumption. The use of DEA for our approach is done as follows:

A. **Classification:** Each context-aware system shall be classified into a group and classified between them.

B. **Splitting:** Each group is evaluated using Data Envelopment Analysis and the relative use of energy done by each context-aware system in the group. For each one of these context-aware systems, a second evaluation is done according to their equivalent and exchangeable contexts. Once their equivalent and exchangeable contexts have been determined an evaluated between them, a decision is taken:

   a. *Equivalent contexts:* In case that two or more equivalent contexts have been found in the system, it is necessary to determine if the information provided by both of them is being used in the system or one of them can be switched off.
   b. *Exchangeable contexts:* In case there are two different context-aware systems installed in the device providing for the same solution, it is necessary to determine which one is suitable for the system (the less energy expense done, according to the energy policy) and if the solution provided by them is used by the system or both can be switched off.

5. Conclusions

Context-aware systems are in fashion nowadays and seem to be improved due to the evolution of daily life mobile devices and the possibility of the creation of a new community and the inclusion of new developers in it.

However, the evolution of these systems should be done in time with an intelligent use of the resources and energy expenses. Our approach uses the Data Envelopment Analysis (DEA) in order to determine the relative energy use of each application and manage them.

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