Social Collaboration of Intelligent Electrical Devices to Enhance Energy Consumption

Juan López-de-Armentia
Deusto Institute of Technology
- DeustoTech
University of Deusto
Avda. Universidades 24
48007 – Bilbao, Spain
juan.lopezdearmentia@deusto.es

UbiComp '13 Adjunct, Sept 8-12, 2013, Zurich, Switzerland.
ACM 978-1-4503-2139-6/13/09...$15.00.

Introduction

In recent years we are witnessing an exponential growth of information technologies in the form of consumer devices. Such a substantial increase of electrical devices must be absolutely followed by government guidelines and policies to restrain the ecological footprint that these appliances will cause in their overall life-cycle. Our society should take a essential active role in such a major concern. Thus, we have to become more aware of energy waste. However, to some extent, appliances' designers and industry have forgotten the latter statement. That is, they have mainly focused their efforts towards energy efficiency and energy-waste awareness within households - where motivational approaches towards sustainability are aimed to individuals rather than to groups. Surprisingly, the public areas, have remained relatively unexplored despite its great potential for energy savings.

My research idea is motivated by the need to deal with the energy waste that we unconsciously do in public areas, and by the demonstrated fact that people do inappropriate and inefficient use of power consumption devices during their operation [5].

In the field of commercial Eco-awareness systems, there are several physical gadgets which are designed to make visible the energy consumption in real-time (electricity

feedback systems). For example, *Wattson Solar*, the *Energy Orb* or *Onzo*. *Current cost* is a more powerful meter with embedded Internet connection to send data to its associated web-site and *nest* is an intelligent thermostat which learns when somebody is at home to adjust the temperature. These commercial devices are designed for people's settings (i.e. individual use), while my thesis research advocates for collaborative Eco-aware objects to tackle energy saving in public spaces.

Most of the reviewed approaches are stand-alone meters, devices or applications -i.e. solutions which are designed to operate autonomously without any kind of interaction nor cooperation with different devices. Indeed, most of them target, as well as commercial devices, to households. Furthermore, the revised literature [2, 9] is mainly aligned with promoting human behaviour change and people-awareness, whereas the proposed approach is focused in the dynamic and automatic collaboration among similar smart Eco-aware things.

Description of planned research topic and work in progress

My research is based on a series of research-experiments aiming to reduce the energy consumption of devices of collective use within public areas through the Eco-aware everyday things concept [5, 1, 6].

In a previous work, a proposal [6] was presented, where Eco-aware everyday things, namely, a coffee-maker in our experiment, were able to improve their energy efficiency operating differently as a function of their usage pattern. To perform accurate usage predictions, these devices required a usage-data collection period (30 days in [6]). In that work, the energy consumption was measured and it was demonstrated that the energy saving potential of learning the usage pattern and make predictions with these 30 days, was about 15%. The first week energy consumption was 928 Wh, so according to [6], after the learning phase the coffee-maker would save 15% per week, i.e. around 140 Wh per week. To get some idea on what we can do with this saving, we can completely charge the mobile phone approximately 25 times. This means that any reduction of the aforementioned learning period, will lead to a reduction of energy consumption.

The proposed doctoral thesis opens a new path to reduce energy consumption by using cooperative objects [7]. The strategy is centered in a dynamic and automatic collaboration among similar smart Eco-aware things towards energy efficiency. It is not only important that they are similar things, but also that they are in environments with similar features. Being the main idea enabling Eco-aware appliances to interchange their collected usage pattern with newcomer devices located in similar environments, the goal is to let the latter ones accelerate their learning time in order to perform, as soon as possible, accurate usage predictions to save energy. Therefore, to tackle the cold-start problem [8].

Hence, the hypothesis of my PhD research is the following:

"It is possible to reduce electrical devices' energy consumption by automatically commuting its operation mode, based on a collaborative learning with other devices"

The next step to solve it is to design a communication platform in order to enable Eco-aware appliances to interchange their usage pattern with others that have a similar profile. The modelling of Eco-aware things' profile is pivotal, because a good modelling is going to make a difference between a great and bad similarity search. It is

necessary to model all the characteristics (number of users, time-zone, hours of light, nationality, kind of activities carried out in its public area, etc.) that can influence in the Eco-aware things' usage.

In [5] was proposed the use of social networks as appropriate platforms to bridge the communication between people and Eco-aware objects. Twitter was selected since it was the most influential and least intrusive of the reviewed networks. Indeed, with more than 200 million users and roughly 400 million tweets per day, Twitter is the most prominent micro-blogging service available nowadays on the Web. The research community is exploiting this service for several purposes (trends predictions, incidents detection, influential users, and so forth). I consider that Twitter can also be a good platform to make Eco-aware objects communicate and cooperate between each other, because I think it allows all the functionalities. That is why I have focused my research in this social network.

There are investigations that aim to find similarities among Twitter users [3, 4] to recommend information or similar users to them. The users similarity problem to make user's recommendation is not new. There exist two approaches: *i)* Content-based, which was a well known method on P2P networks -i.e. people with similar content to share is prone to be similar; *ii)* Collaborative filtering -i.e. it is the process of filtering using techniques involving collaboration among multiple agents. In Twitter the typical approach is the latter, collaborative filtering. The features that are most commonly used to group users together are: user profiles (usually constructed by a specific user modelling strategy [10]), Twitter lists, hashtags or retweets [3].

In spite of these large research efforts, the user recommendation in social networks is a non-trivial task. Collaborative filtering approaches exhibit a high computation when the population is large [11] and any of the state-of-the-art methods suffers from the same limitations: sparsity and scalability [11] and cold-start problems [8]. Probably the most important one is the latter. New users, in our case newcomer Eco-aware objects, can continuously join to the system and they do not have any information of similar devices with whom to share relevant information. Hence, the cold-start issue tends to be severe in these social platforms when compared to traditional information systems.

Although I have focused the communication infrastructure in Twitter social network, I am opened to other perspectives that could fit better with this issue. The experts opinion would be very valuable to determine next steps of research.

Objective for attending the Doctoral School

The main objective is to make known my research ideas to receive feedback that will help me to define my research questions, approach and contributions. Experts' opinion is very important for me to guide the next steps of my research.
Indeed, exchanging ideas with other researchers in the same area would be very useful for my interests.

Brief biographical sketch

Juan López-de-Armentia received his diploma in Computer Engineering in July 2008 from the Mondragon University. In 2009 joined Tecnalia Research Innovation and received his master degree in Control Engineering, Automation and Robotics in September 2011 from the University of Basque Country. In October 2011 he joined MORELab, a research group behind the Internet and

Telecom units of DeustoTech - Deusto Institute of Technology at the Faculty of Engineering of the University of Deusto, where he is developing his PhD and works in topics related to Internet of Things, Energy Efficiency and Eco-aware Things, supervised by Dr. Diego López-de-Ipiña. Juan López-de-Armentia did the PhD registration on September 2012 with the prospect of defending the doctoral thesis during the year 2015.

References

[1] Casado-Mansilla, D., López-de Armentia, J., and López-de Ipiña, D. Will eco-aware objects help to save the world? In *Proc. UCAmI'12* (2012), 17–24.

[2] Froehlich, J., Findlater, L., and J., L. The design of eco-feedback technology. In *Proc. CHI'10* (2010), 1999–2008.

[3] Hong, L., Doumith, A., and B.D, D. Co-factorization machines: modeling user interests and predicting individual decisions in twitter. In *Proc. WSDM'13* (2013), 557–566.

[4] Kim, Y., and Shim, K. Twitobi: A recommendation system for twitter using probabilistic modeling. In *Proc. ICDM'11* (2011), 340–349.

[5] López-de Armentia, J., Casado-Mansilla, D., and López-de Ipiña, D. Fighting against vampire appliances through eco-aware things. In *Proc. IMIS'12* (2012), 868–873.

[6] López-de Armentia, J., Casado-Mansilla, D., and López-de Ipiña, D. Reducing energy waste through eco-aware everyday things. *Mobile Information Systems* (2013). To appear - Manuscript accepted for publication.

[7] Marrón, P., Karnouskos, S., Minder, D., and Ollero, A. *The emerging domain of Cooperating Objects*. Springer, 2011.

[8] Nguyen, A., Denos, N., and Berrut, C. Improving new user recommendations with rule-based induction on cold user data. In *Proc. RecSys'07* (2007), 121–128.

[9] Pierce, J., and E., P. Beyond energy monitors: Interaction, energy, and emerging energy systems. In *Proc. CHI'12* (2012), 665–674.

[10] Prantik, B., Ankush, G., and W., S. Analysis of user keyword similarity in online social networks. *Social Network Analysis and Mining 1*, 3 (2011), 143–158.

[11] Sarwar, B., Karypis, G., Konstan, J., and Riedl, J. Item-based collaborative filtering recommendation algorithms. In *Proc. WWW'01*, ACM Press (2001), 285–295.