Eliciting Affordances for Smart Objects in IoT Era

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Abstract. In this paper we suggest a design research method for eliciting affordances and new meanings for Smart Objects in the Internet of Things Era. After an introduction to the topic and the description of some open issues, we propose to adopt a Critical Design approach, where the role of Ambiguity is twofold: on the one hand, it is the objective of the observation for defining a set of ambiguous objects or affordances; on the other hand, it is the result of a design conceptualization of smart objects aiming at provoking cognitive dissonance and finalized to understand people adaptation processes and behaviors.

Keywords: Human-Computer interaction · Critical design · Cognitive dissonance

1 Introduction: Object, Smart Object, IoT

Until recently, people have been used to considering physical objects as material to interact with for performing various tasks. The human capabilities for completing a task are enabled by the object's properties. We refer to these properties as 'natural elements' existing in objects and which help people to interact with the objects themselves. Moreover, these natural elements define a shared knowledge that people gain while interacting with the objects without activating of expensive learning processes.

In the last decades a new paradigm has been introduced in the conceptualization of physical objects [1]. The growth of embedded technology [2] in everyday objects [3], and their organization in a nexus of elements, is introducing a new meaning for objects and it is a suggesting new ways of interaction with them. Internet of Things (IoT) is the concept under which we collocate these new nexus of physical objects and interactions.

The IoT [4] allows going beyond what people foresee and it opens a new opportunities in exploiting objects' properties. In this perspective, the evolution is going in the direction of changing the shape and the appearance of objects augmenting their natural function with something new. Furthermore, the existing affordances in connected and technologically augmented objects are becoming unable to immediately communicate to people their actual values and meanings.

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This new type of object is called Smart Object. The capabilities of a Smart Object go beyond what its aspect shows and what people can image, combining knowledge and insights derived from the original physical object.

The impossibility of establishing a clear connection between objects and functionalities could become a threat for humans, since they are missing their innate ability to understand what they can do only based on their knowledge and perception of the surrounding context. As an extreme consequence, with the spreading of the IoT and smart objects people could loose the ability to use everyday objects to accomplish their tasks. How can we solve this extreme situation?

2 Theoretical Background

The concept of physical affordance appears for the first time in Gibson's research [5], where he defines an affordance as a clear coupling between the meaning of an object and the actions that it allows. Norman [6] simplifies the term introducing the idea that affordance is a property that suggests what users can do with the object. Stimulating people's actions, the affordance suggests the correct way to interact with an object, inviting people to do something. Norman also introduces the existence of a combination between what an object suggests, what people perceive to be able to do and what really happens. In a successful case, there is a total combination between these aspects, in a negative case, instead, he describes the existence of gaps ("gulfs") between what people are thinking to do and what they are actually doing.

3 Cognitive Dissonance in Iot Era

The distance [7] between physical affordance - object properties suggesting interaction- and cognitive affordance - the way people perceive how they could interact with an object - can be formalized using the psychological definition of cognitive dissonance. The lack of a clear coupling of physical and cognitive affordances makes the situation confused and weak. The perceived inconsistency between knowledge, feelings and behavior establishes an inner state of discomfort - cognitive dissonance - that people try to reduce [8]. If this inconvenience is very common, it becomes more than common in IoT and Smart objects. People are continuously stressed by a new and unexpected use of components of surrounding environment that they are disabling to have a deeper comprehension of it.

The dissonance is perceived as psychologically uncomfortable, thereby people are stimulated to reduce or delete it, thus it are stimulated to reduce or delete it changing their behaviors and their beliefs about context and their components.

This theory is based on the recognition of the existence of knowledge [9] on which people build their behavior, and, more generally, build themselves. If something damages this balance, people immediately perceive a tension, a cognitive dissonance, and they try to react to it.

In a world of IoT and Ubiquitous computing, when "technologists" build smart objects, technologists tried to adopt the natural affordances present in objects to allow

people to understand the way in with get in contact and use them [1, 2]. However, when we, as "designer", are thinking about an object provided with more powerful capabilities and functions, we are thinking about something that could go beyond the usual way of interaction. Anyway, Smart objects make hard the people understanding of the real values and meanings of objects through their affordances. What we are observing is the growth up of dissonance perceptions. The emergence of discordance between meanings and coupling [10] appears almost evident.

4 A Critical Design and Smart Objects

Starting with cognitive dissonance as an issue, we suggest to use it as a positive resource for designing smart objects with suitable affordances. With this aim, we propose to introduce cognitive dissonance as part of a methodological approach exploiting Critical Design. Dunne and Raby propose Critical design as a new form of research [11] aimed at provoking critical attention from users about how the design of objects, their shape and their representations influence values, ideologies and their behavior. Supporting Dunne and Raby's research idea about design [11], we adopt this innovative approach to provoke people's reaction and to stimulate their 'critical sensibility' in analyzing their relation with the surrounding environment. In fact, stimulating the development of critical attitudes in users, we are able to study the outcomes for defining critical and innovative insights about future concepts. Stressing cognitive dissonance we would like to introduce ambiguity in Smart Objects and then provoke reaction in users for studying them [8].

5 Eliciting Affordances for Smart Objects

We intend to exploit the lack of clear principles for eliciting affordances or new meanings in smart objects by suggesting a design research method, on top of the critical design approach, where the role of ambiguity is twofold: on the one hand it is the objective of the observation to define a set of "ambiguous" objects or "affordance"; on the other hand it is the result of a design conceptualization of smart objects aiming at provoking "cognitive dissonance" and finalized to understand "adaptation" processes and behavior [9].

Critical Design approach is receiving much attention in the Human Computer Interaction and Design research and its adoption is controversial and many ongoing discussions [12] focus on how to define a critical design theory suitable for HCI research and practice. Within this new trend we intend to propose a design research method capable of "informing", gathering information, useful in the conceptualization of Smart Objects.

For assessing our research method we are setting up a two steps experiment:

(a) First, we define a set of everyday objects (i.e. a pencil) and then observe in which way people interact with them, how they adopt affordances and how they apply different interpretation while getting in touch with them. The observation is

carried on as ethnography [13] a sociological method, for understanding the objects in the "context of use" and highlighting the existing interrelationships between users and objects, and users and users with objects.

(b) Second, we introduce "in the wild" a set of smart objects (i.e. a smart pencil), strictly related to the objects of the previous step, containing ambiguity in meaning and affordances and then observe the 'adaptive behavior' that people adopt as natural consequences of a state of cognitive dissonance [14].

This study will benefit from previous work concerning the embodiment of the interaction into smart objects [15–17] and critical design experiments [18].

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