The Role of the User in the Social Internet of Things - Open Questions and Research Agenda

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Abstract

With the growing ubiquity of smart devices and their on-going technological advancement, the role of the user in the Internet of Things steadily changes. With the emerging Social Internet of Things it gets even more important to evaluate this role. A central aspect of this concept is the autonomous inter-object interaction. Objects are expected to communicate invisibly and establish friendship relations among each other as known from social networks. This paper reviews the user's role within the Social Internet of Things as well as the user's goals and needs. Therewith, this paper works out research challenges which have not been sufficiently answered yet. Exemplarily, the growing autonomy of the devices is critically reviewed as well as its effects on the user. Simultaneously, first steps for methodological setups are proposed for further evaluations.

Author Keywords

Ubiquitous Computing; Social Internet of Things; User-Centered Design; Personas.

ACM Classification Keywords

H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous

Definitions of the Social Internet of Things

SIoT is a paradigm, where "[...] objects are capable of establishing social relationships in an autonomous way [...] with the benefit of improving the network scalability in information / service discovery"(Nitti et al., 2014 [11]).

In the SIoT, devices "[...] will communicate with each other autonomously without any centralized control and collaborate to gather, share, and forward information in a multihop manner"(Bello et al., 2016 [4]).

In the SIoT, the user can "[...] only access the results of autonomous inter-object interactions occurring on the objects' social network"(Tripathy et al., 2016 [13]).

Introduction

In recent years, the Internet of Things (IoT) evolved to be more than a network of interconnected devices. Through the improved technological functionalities and the growing ubiquity of smart devices, the users' role in the IoT changes. By introducing the concept of the Social Internet of Things (SIoT), the concept of IoT was extended by social networks functionalities. In the SIoT, objects are able to communicate autonomously and establish relations (e.g., parental or friendship relations) among each other as common in human social networks [3]. Until now, research has addressed many of the technological challenges and opportunities the SIoT brings along, but insufficiently covered the user's perspective.

First, this work sheds light on the different definitions of the SIoT. It is derived which role the users are supposed to take when interacting with the devices. In the second part of this work, the relation between the users and their smart devices is further investigated. Open research issues are revealed as well as positions which are insufficiently targeted by prior research. A short research agenda is stated, while simultaneously formulating methodological starting points to address the goals of the agenda.

Defining the Social Internet of Things

When reviewing the definitions used to describe the SIoT, the only common statement in every perspective is the basic idea of enriching the IoT with social network components (see side bar for quotes of the definitions). A definition proposed by Nitti et al. [11] describes the SIoT as a paradigm, where social objects autonomously establish relations to improve information and service discovery [11]. A more basic description by Bello et al. [4] focuses on the requirements ascribed to the devices, which are communicating autonomously and are able to collaborate to gain

and share information [4]. Emphasizing the dependency of user and devices, one further definition is stated by Tripathy et al. [13]. It includes that there is an autonomous interactions between the objects within their social network and the user is supposed to take a passive role by just viewing the results of this interaction [13].

In contrast, definitions of the IoT emphasize the growing ubiquitousness of smart devices [14], their pervasiveness around us as and the basic functionality that objects "[...] are able to interact with each other and cooperate with their neighbors"[2]. Looking at the various definitions of the SIoT, one will notice different emphases on certain aspects. Therefore, there is not one general definition which is accepted and reused by the community. But one central aspect of the SIoT stated in most of the definitions is the devices' autonomy. They are progressively more independent in establishing relations among each other, communicating, and making decisions. Opposing to this, the control exerted by the user simultaneously decreases. Therefore, there is a noticeable shift regarding the users' role when comparing their position in the IoT with their position in the SIoT.

Research Agenda

A central aspect derived from the definitions of the SIoT is the change in users' role in a network of inter-device communication. Users are put in a position, where they only interpret the results of an otherwise device-only interaction [13]. Their role can still be an active one, although their interaction might become less explicit. The devices are expected to communicate autonomously with each other and it is seen as advantage for the user that the system can work without human control [12]. Without raising questions on the advantages of the system, research should also consider possible negative consequences of autonomous systems. Evaluations could look at the users' attitudes towards

privacy, a lack of control, or a decrease of transparency. This central change within the relationship of users and objects now leads to many open research issues as outlined in the following:

- How do the users interact with devices in the SIoT?

- How do the users feel about to the devices gaining more autonomy?

- Does the autonomy of the devices influence the users' feeling of control and privacy?

- How does the autonomy of the objects effect the users' role in the design process?

Of course, it is not possible to answer all these questions within the scope of this paper. Therefore, the following section will present first steps towards further evaluations.

The User in the SIoT
Although the technological components of the SIoT constantly improve, we still have a sparse understanding of the users. To understand how people interact with the devices and how they feel about certain aspects like privacy or control, the obvious first step is a thorough analysis current and future users. A starting point to picture the users of the SIoT is to define personas. Personas have proven to benefit product design by helping prioritize both the most important audiences and the product requirements, and by focusing the product development on the users and their goals [8]. Furthermore, the definition of personas helps individuals such as designers realize how the users are different from themselves [8]. It provides deeper insight into what value the product will create for the users [9].

To define personas, Nielsen et al. [10] introduce a ten step plan for a bottom-up analysis (see sidebar). Since the approach is very open, a more specific data collection to define the personas might have advantages. Refining this approach, a procedure focusing on a specific scenario could reduce effort and decrease noise within the data. Since we want to find out more about people engaging with the SIoT, it could be helpful to create a specific use case scenario to evoke technology engagement even before collecting data.

Therefore, the methodological approach of defining personas can be adapted to a specific scenario as follows: (1) Defining one or more scenarios where people engage with the technology (e.g., a smart home, an office situation, or a smart hotel room); (2) Building experience and literature based hypotheses; (3) Engaging with the users in a certain use case; (4) Finding patterns and categories within the user data; (5) Verifying the categories through qualitative data on personas needs / values / likes (e.g., privacy perception, the users' views on social networks, users' need for participation in the design process, or need for control); (6) Constructing the personas; (7) Validating personas in specific situations; (8) Re-evaluating persona definitions if necessary.

Still, it is important to see the persona definition as part of a design process and it should be combined with qualitative user data to not be confusing or misleading [7].

Objects as Part of the Design Process
Since the users are supposed to be less engaged in the SIoT regarding their influence and control, an interesting approach for the design process could be to look at the objects. By stepping away from a user-centered design process, the focus would be on the perspective of the objects. Objects are already exploited to be a way of interaction by extending every day object for communication purposes.

You can call your grandparents via a kettle while boiling tea water [5] or secretly write messages via a small LCD display in your mug [1]. So since we know that objects can work in different purposes than originally planned, why don't we ask the objects themselves what functions they have? Cila et al. [6] investigate data generated from everyday objects like a kettle via a logging device as well as visual and numerical data. The researchers look for patterns like time of the day, presence of other objects, or movements by machine learning techniques. But even though the objects can bring a new and interesting perspective for the design process, the user has to still be included to address his goals and needs to ensure a satisfying user experience.

Conclusion

This paper dealt with conflicts and open research issues in the field of the Social Internet of Things and proposes methodological implications for human-centered research and design approaches. It is examined how the user is expected to act in an environment of smart and social devices. The increasing autonomy and its effect on the users role should be critically reviewed. It is suggested to take a step back and examine the users' goals and needs and derive design suggestions based on the findings.

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