IUIoT: Intelligent User Interfaces for IoT

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ABSTRACT

As IoT devices begin to permeate our environment, our interaction with these devices are starting to have a real potential to transform our daily lives. Therefore, there exists an incredible opportunity for intelligent user interfaces to simplify the task of controlling such devices. The goal of IUIoT workshop was to serve as a platform for researchers who are working towards the design of IoT systems from an intelligent, human-centered perspective. The workshop accepted a total of five papers: two position and three extended abstracts. These papers were presented by the authors and discussed among the workshop attendees with an aim of exploring future directions and improving existing approaches towards designing intelligent User Interfaces for IoT environments.

CCS CONCEPTS

• **Human-centered computing** → **User studies**; **User interface management systems**; *Ubiquitous and mobile computing*.

KEYWORDS

Internet of Things, Intelligent User Interface, Smarthome

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1 WORKSHOP TOPIC AND GOAL

Under the moniker of 'Internet of Things' (IoT), smart connected devices are revolutionizing our everyday life. The main feature of IoT devices, which range from personal devices [1, 4] (e.g., fitness trackers, smart speakers, smart home appliances) to devices deployed in public areas and "smart cities" (e.g., smart billboards, RFID trackers, CCTV cameras) [1, 7, 11], is that they are connected to a larger network of devices via local communication protocols and/or the Internet. IoT devices are about to dethrone smartphones as the largest category of connected devices [2], with Gartner [15] forecasting a total of 21 billion IoT devices by 2020.

This exponential growth of connected devices comes with an incredible potential for innovation. However, the vast increase in their number and complexity also suggests that controlling these devices can become an incredible burden on the user. There exists a risk that users will simply treat these smart devices as their "dumb" counterparts, and/or not understand the implications of their connected nature [10].

Hence, an incredible opportunity exists for *intelligent user interfaces* to simplify the task of controlling IoT devices, thereby unlocking their transformative potential. Interestingly, though, there is a paucity of IoT-related work in the IUI community. Notable exceptions are Bahirat et al. [1], who address the development of a smart privacy-setting interface for public IoT devices; Mennicken et al. [9] who leverage users' mental models for calendars as an interaction paradigm for IoT interfaces; Jeong et al. [5] who take a cross-cultural perspective investigating design strategies for IoT; and Massimo et al. [8], who leverage public sensors to build a places-of-interest recommender system.

Given the relative lack of IoT-related work in IUI, we organized an interactive workshop to create a well-informed, connected community of researchers interested in developing and testing intelligent user interfaces for IoT. This workshop followed a presentation and follow-up discussion format enabling the presenters to gain feedback about their ongoing work in IUIoT domain.

2 WORKSHOP PROGRAM COMMITTEE

The following scholars served as program committee and we are grateful for their contribution towards the workshop:

- Xinru Page, Bentley University, USA
- Pamela Wisniewski, University of Central Florida, USA
- Ilaria Torre, University of Genoa, Italy
- Richard Chow, Intel Research, USA
- Carmelo Ardito, University of Bari, Italy
- Tsvi Kuflik, University of Haifa, Israel
- Francesco Ricci, Free University of Bozen-Bolzano, Italy
- Federica Cena, University of Torino, Italy
- David Massimo, Free University of Bozen-Bolzano, Italy

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3 KEYNOTE

In this new age of IoT, people and things are increasingly immersed in a computing environment that is aimed to simplify and improve daily activities. The Web of Things (WoT) is near to become a W3C Recommendation with the aim to support semantic interoperability across IoT platforms by providing a common interaction model independent of the underlying protocols.

In the keynote talk [14], Dr. Ilaria Torre illustrates the main principles of the WoT paradigm and then discusses the issue of Accessibility. Following on from the WoT concept of Things as virtual representations of physical digital things and also non-digital things, the talk also discusses an idea that through the virtualization of physical objects, even objects which are not natively accessible can be augmented to become accessible and inclusive if proper adaptations are performed in order to fit the user's needs.

4 ACCEPTED PAPERS

In this workshop, we accepted a total of five papers; three extended abstracts and two position papers. These papers discuss wide range of challenges associated with user-centered design of IoT systems. Ranging from understanding sharing strategies adopted by smart homes users to the intelligent personalization of IoT platforms. The paper also looked at diverse IoT platforms ranging from smarthome environments to smart highways.

Smarthome IoTs comprising a wide variety of devices affect the lifestyle of the occupants of these smart homes. These effects are especially prominent for younger populations. Sengupta and Garg [13] discuss a proposition to apply Social Learning Theory with an aim to understand 'observational learning' in terms of how children learn through observing and interacting with smart devices, specifically using voice-based commands. Smarthome IoT devices have the highest proximity to the most intimate spaces of their users, and most often these devices are shared by multiple occupants of a household. Garg and Moreno [3] present preliminary findings from an ongoing study to explore sharing practices adopted by users of smarthome IoT devices and propose recommendations for designing them. Sometimes, a user's smarthome device is also shared by people who are outside their intimate circle, such as close friends or casual guests in the house. Jha et al. [6] discuss the findings of their pilot survey study which delved into understanding various motivations and concerns that affect IoT device owners decisions when it comes to sharing their smart devices with users in their outer circles.

Wiegand [16] discusses various challenges and benefits associated with smart highway systems. Her focus group study identifies several benefits, including enhanced safety on highways by means of early warning mechanisms. The paper also sheds light on challenges such as the accuracy of sensors classifying objects on highways.

Paterno and Alawadi [12] discusses the integration of personalization in IoT environments through trigger-action programming, which allows end users without programming experience to customize the context-dependent behaviour of their applications through the specification of trigger-action rules. They propose to use machine learning and recommendation techniques based on collaborative filtering or rules to discover patterns and regularities between behaviours, context conditions, and user features.

From a broader perspective, all the papers sought to provide suggestions about designing IoT interfaces which was supported by the findings from the user research. We hope that discussion of these works will be helpful to the authors for moving forward with their research and that with this workshop we took the first step to build a community of researchers working in IUIoT domain.

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