CONN-EX:

User Experience Challenges in the Connected Age

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Abstract—**We are now facing one of the largest wave of disruptive changes, the Internet of Things (IoT). As we think of the promises of a 'smart city' powered by IoT, what it can bring to our lives can be exciting. Focusing only on the technology or business aspects, however, will lead to failure in user adoption as we all learned from earlier attempts. This special track of ACHI 2017, abbreviated as CONN-EX, intends to address the user-side stories of various IoT applications. Seven papers highlight the user experience practitioners' challenges in a wide variety of IoT domains. Attendance at the CONN-EX special sessions will help professionals and practitioners identify critical issues, define problems, develop a winning strategy and solutions, and adopt the right process and methods that can lead to success.**

Keywords—User experience; Internet of Things (IoT); smart city; connected; multi-device; wearables

I. INTRODUCTION

With the promising vision of Internet of Things (IoT) ahead, we are now entering a connected, multi-device age. Studies report that 'connectedness' is changing the way people interact with the world: their tasks, workplaces, environments, or coworkers. People are now consuming contents across multiple devices all day long. People own multiple products (e.g., smartphones, tablets, speakers, etc.), put them in a number of places (e.g., home, office, car, etc.) or carry them around everywhere, and want to use them together to accomplish their goals. They expect the products together to work in harmony, so that they can always stay connected and do not want to miss anything whenever and wherever they are.

IoT has been one of the most hyped buzzword in the IT industry for years. The potential benefits of IoT applied to a variety of domains attracted the interests of the professionals and practitioners in both industry and academia. There is no doubt that IoT will be the next wave of disruptive changes strong enough to redefine the landscape of the global industry [1].

The growth of consumer IoT market, however, is not as fast as we initially expected [2]. Analysts report that lack of interoperability, use of unfamiliar technological terms, and lack of empathic understanding of user needs are among the most critical reasons that lead to failure in consumer adoption [3]. In fact, connected devices cannot talk to each other, and each device comes with its own app, which can confuse users. People still do not understand what IoT means when they hear about it. Even if they did, people are not convinced enough to the promises of IoT. They are not sure if it can somehow help them solve the real problems they struggle with every day.

In order to realize the potential power of IoT and ignite the growth of its market, it is most important to understand what people want and offer them a smart and mature multi-device experience that works as an 'ecosystem' optimized to help them accomplish their goals.

Accordingly, the landscape of user experience practices in various IoT domains is drastically changing. This special track, abbreviated as 'CONN-EX', intends to address the 'user experience challenges in the connected age', focusing mainly on the user aspects of IoT applications. Seven papers highlight the challenges and research efforts in a variety of application domains aiming to make the IoT business more people-friendly.

II. WHY USER EXPERIENCE MATTERS FOR IoT

'Connectedness' has long been a challenging mission for designers and engineers in the global IT industry. Early efforts for designing connected products focused on the usability or technical aspects of connectivity functions, such as devising new methods to connect and share files easily from one device to another. Companies marketed connectivity as a new unique sales point, but people were not attracted to these new features so much. The benefits of

having connectivity features were not big enough to pay off the cost of deploying connectivity features in the products.

Companies then started seeking for new business opportunities using connectivity functions hoping to make up for the slow-down or stagnation of the mobile market growth. As a result, they launched various multi-screen services and internet-ready products competitively into the market. The outcome, however, was far less than the market expectations.

Lessons learned from these earlier attempts remind us of a basic principle of design thinking that the starting point of innovation should always be the 'People.' The 'desirability' from the people point of view should receive the first and highest priority compared with technological feasibility or business viability. In addition, genuinely valuable innovation arises at the intersection of those three aspects as shown in Figure 1.
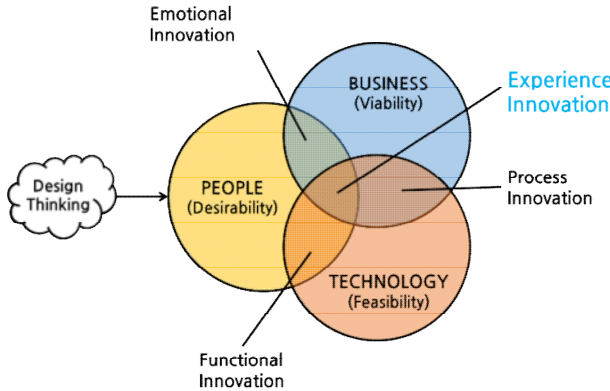

Figure 1.   Scheme of innovations including people, business, technology and design thinking, adapted from [4]

Powered by IoT, smart city scenarios are exciting. It ranges from smart personal devices that help people stay fit and healthy; to a secure and convenient living environment; to connected, self-driving cars; to smarter workplaces; to smarter factories, to name only a few. Recently some products and companies started to appear in the market mostly as startups. Summarized in Table 1 is the classification of IoT domains along with some examples of the representative products or companies in each category.

With the emergence of IoT, companies are now facing one of the greatest opportunities in history. But, at the same time, they are facing more complicated challenges than ever before. Although IoT is arousing enormous interests of business and technology, a majority of people on earth, i.e., the consumers, are still ignorant or indifferent of it. As we learned from earlier attempts, central to IoT and the smart city vision should always be the 'people.' To be successful in IoT, user experience should be considered the most important part of business or market requirements. Designers should be involved in strategic and technological discussions from early stages. To win the game, they have to collaborate even with the rivals to offer holistic user experience with a perfectly coordinated 'ecosystem,' despite mixed product combinations of different device types, brands, or platforms.

TABLE I.   IoT DOMAINS AND PRODUCT EXAMPLES

IoT Domains			Examples (Products / Companies)
Consumer	Personal	Entertainment	SONOS, Razer
		Wearables	Samsung Gear, Apple Watch, Pebble
		Fitness/Sports	Fitbit, Jawbone, Garmin
		Health	Withings, EarlySense
		Family Care	Ily, Lively
	Home	Entertainment/ Automation	Amazon Echo, Google Home, SmartThings, Nest, Comcast, Control4
		Security	Canary, Vivint
		Home Robots	Kuri, Jibo
		Smart Appliances	Samsung Family Hub Refrigerator
Automotive	ADAS[a]		Hyundai, Audi, Benz
	Connected Car Solution		Apple CarPlay, Google Android Auto, AT&T
	Autonomous Cars		Tesla, BMW
	UAV[a]		Parrot, DJI
Public	Transportation		Delta, JetBlue, Amtrak, Greyhound
	Smart Building		Johnson Controls, Cisco, Honeywell
	Emergency Management		Ericsson, ShotSpotter
	Environment		Lapka, AirBot, PressureNet
Industrial	Industrial Wearables		APX, Apple, Google
	Energy Management		EnergySavvy, EnerNOC
	Supply Chain Management		Resilinc, ClearMetal, Locus Robotics
	Machines/Robotics		ABB, KUKA
	Smart Manufacturing		Bosch, SIEMENS
Enterprise	Smart Office		Herman Miller, Humanyze
	Healthcare/Medical		AdhereTech, Augmedix, EarlySense
	Retail		Amazon
	Financial		PayPal, Intel & Ingenico, NXP & Qualcomm
	Agricultural		OnFarm, CropX, FarmX
	Travel/Hospitality		Starwood, Hilton, Telkonet EcoSmart

a. ADAS: Advanced Driver Assistance System
b. UAV: Unmanned Aerial Vehicles (Drone)

III.   SUBMISSIONS

In that context, we proposed this 'special' track, abbreviated as CONN-EX, as a 'round table' of open discussion for those who are practicing user experience or related jobs in a variety of domains. It is organized in two subsequent sessions, in which seven papers will be presented. The papers in two sessions are classified around the categories of IoT domains.

A.   Session 1: Practices in the Consumer IoT

Session 1 presents an overview of the special track followed by three papers related to the consumer IoT domain.

Designing for 'multi-device' experience is one of the most difficult yet exciting challenges of user experience. As the buying power of the millennials grow, making products ready for multi-device usage becomes more important, because they take it for granted to consume contents across multiple devices whenever and wherever they are. **Lee, et al. [5]** aims to understand the key behavioral characteristics, usage patterns, needs and requirements of millennials with the focus on their multi-device usage. What is unique about this study is that the authors applied statistical methods in defining personas and use cases.

Choi, Bae, Kim, Yoon, and Chung [6] explains the process and outcomes of designing the user experience of a smart headwear for bike users. They also demonstrate the comprehensive user experience design process applicable to any new products in the IoT era.

Key to success of an IoT application is the usefulness or the perceived value that can make customers adopt the service. **Park, Kwahk, and Han [7]** presents an example of IoT applications that can make the life of the parents a lot easier by helping them out in feeding their babies.

It will be beneficial to share the process, methods and the lessons learned with other researchers and practitioners.

B. Session 2: Practices in the Automotive, Public, Industrial IoT and More

Session 2 includes four papers from automotive, public and industrial IoT domains and a wrap-up discussion.

Automotive is probably one of the first business domains that adopted IoT. One of the key characteristics of the IoT-powered automotive business environment is the increased importance of data analytics in developing products and services. For example, utilizing the vehicle CAN (Controller Area Network) data is considered promising in evaluating the ADAS functions such as lane keeping assistants. However, it can be extremely time-consuming without an appropriate support for the evaluation crews in handling and analyzing data collected from the vehicle. **Jang, et al. [8]** has developed a user-friendly data analytics tool, and the process and outcomes will be explained.

Suggested by **Jeong, et al. [9]** is the ideation process and framework to enhance the pedestrian experience in the smart city context. They focused especially on those who have mobility challenges on the road such as seniors, kids, and the physically challenged. Based on the research of people, spaces, and tasks, they suggest an ideation framework effective especially in the divergent thinking phases of problem solving.

Jeong, Han, Jeong, and Kang [10] presents a smart safety helmet, an IoT-based solution designed to prevent unsafe acts in a challenging working environment such as nuclear power plants. The process and methodology applied to come up with the outcomes is beneficial to many practitioners in similar domains.

Although it is hard to predict what will happen in the upcoming IoT era, one thing seems to be quite clear. The companies are more likely to be small- to medium-sized, which may not have enough expertise in the user experience

domain. The motivation of the study by **Park, et al. [11]** is to help those companies out to make the products more usable and deliver better user experience.

IV. CONCLUDING REMARKS AND FUTURE DIRECTIONS

IoT is applicable to virtually any business sector or industry domain. Therefore, it is reckless to say that we can cover the wide variety of IoT domains with only seven papers presented in this special track. Rather we just opened a round table for open discussions among the practitioners in various domains. And the table must go on.

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