The First Interaction Design Pattern Library for Internet of Things User Created Applications

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Abstract. In this paper, we report our analysis of extracting relevant existing and new interaction patterns that are candidates as enabling paradigms to facilitate Internet of Thing user created application building. We first define the context and underline what is an internet of thing user created application and what are the main research issues. We stress the focus on Interaction design as a must have paradigm to reach the Internet of thing user created application vision and highlight the research scope. In this paper we contribute with a template based interaction pattern that refers to competitive advantages and limitations with regard to our vision. The research method allowed us to sort out our first library of interaction pattern in this field. We conclude the paper with lab experimentation and lessons learned.

1 Introduction

The term "Internet of Things" (IoT) describes a number of technologies and research disciplines that enable the Internet to reach out into the real world of physical objects. Technologies like RFID, short-range wireless communications, real-time localization, and sensor networks are now becoming increasingly common, bringing the Internet of Things into commercial use. However, beyond the connectivity aspects of every thing or objects, less attention is paid to the value of what the Internet of Things could bring to the user experience. Indeed, we believe that the success of the internet of things will only happen when this phenomenon will actually bring significant value to users and society. Motivated by this vision, we started a new research activity, and proposed a "Do-it-Yourself" project (DIYSE[1]) in which end-users get the tools and the support to create and share their own smart applications and experiences. Our main challenge in this ongoing research track is to let end-users create their own applications for their self-defined smart environment. Therefore, they need to participate in the creation process, where they have the power and control over the creation of and use of the application. Making the parallel with Web2.0 and Web3.0 trends, we expected that the key to open the Internet of Things for mass creativity is depending on: open standards, easy application creation, rich interaction means, and End-User Programming. While a lot of works related to End-User Programming [1,2,3,4] is put in advance by recognized researchers, on which we can leverage, we are concerned that the user-thing interactions

[1] DIYSE project: Do-It-Yourself Smart Experiences http://www.dyse.org

J.A. Jacko (Ed.): Human-Computer Interaction, Part I, HCII 2011, LNCS 6761, pp. 229–237, 2011.

need to be enhanced, and the user-environment interaction would need to be rethought. In fact, bringing the user to the application creation loop in an Internet of Things world will imply: considering existing interaction patterns and End-User programming methods and evaluate them from user control point of view; taking into account; wide segments of users should easily pick up well-defined abstract interaction patterns and make their stimulating experience smart.

In the rest of the paper, we introduce the interaction space in IOT environment from different perspectives. Then, we present our template and discuss the first five interaction patterns we found important for "User created application" research issue.

2 Interaction Space in IOT Environment

Interactions via creative, communicative, social, and functional interfaces, allows smart collaborations between smart objects, users, and their environment. From the objects perspective, users are facilitated to explore phenomena through introspection of smart object roles and collaborations. We agree with Gentry Underwood [8], that we are still far away from smart emphatic interactive objects and phenomena, which design for social, anthropological, and ecological arenas. Or as Gillian Crampton Smith states it as follows: "In terms of perceptual psychology, we're starting to understand the functional limits of interaction between people and devices or systems: speed of response, say, or the communicative capacity of a small screen. But at the symbolic level of mood and meaning, of sociability and civility, we haven't quite achieved the breathtaking innovativeness, the subtlety and intuitive "rightness," of Eisenstein's language of montage" [9].

We collaborate with open design communities and open DIY communities and research the need for new interaction paradigms empowering creativity and sociability at individual and community level as a starting direction in our search for this "rightness". Many innovative projects are popping which explore the balance between the application of new technologies, functionality, need, self-expression, societal statement, empathy, beauty, and personal happiness (e.g. talking tree: a real-life immersive digital prototype on feelings and reflections of a tress somewhere in a street in Brussels, Belgium [2]). Fostering individual user and community creativity requested us to adopt a four-fazed creativity model: inspiration, divergence, exploration, and a convergence faze, where different interactions perspectives are elaborated. In this paper we limit our selves to the convergence phase of the creativity model but we are interested in opening the debate on the "whole" aspect in order to address the entire creativity model.

3 Template Based Interaction Pattern

3.1 Template

Inspired by Web design interaction pattern library namely Yahoo library[3] and Wellie[4], we believe that a interaction pattern library for Internet of Things user created

[2] http://talking-tree.com/
[3] http://developer.yahoo.com/ypatterns/
[4] http://www.welie.com/patterns/

application is an essential tool to enlarge the social network of users creating application and to reach the mass creativity goal we hope to achieve in our future research direction.

We tried to design a simple template that could tell what the interaction is about, what are the main features, what are the similar patterns. The template allows also giving examples, detailing the user creation flow and analyzing the pattern by extracting out the positive points as well as the limitations with regard to allowing non-skilled users to easily interact and create their desired application. The template elements are depicted in next figure.

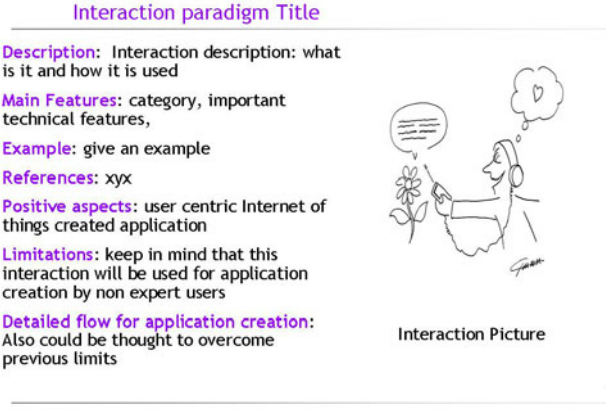

Fig. 1. Template interaction pattern for Internet of Thing user created applications

3.2 Research Methodology

In the first phase, we collected existing interaction paradigms from the Internet (e.g. forums, HCI communities, and books) and followed a series of brainstorm workshops for extra idea generation and selection. After that, we synthesized our finding in 10 interaction paradigms that we presented to a multidiscipline team composed of 10 researchers including computer scientists, creativity coach, designer, sociologist and business analyst. We shared the template and explained its main elements. We asked each researcher to look for new or known existing interaction paradigms and perform an interaction pattern analysis by using the template. After a collection and filtering phase (taking into account the multidiscipline team feedback as well as their individual contribution), we picked out a set of 5 interaction patterns that we will underline one by one in next section. Each analysis (next paragraph) should reflect very clear how non-skilled users would interact with the environment in order to create application using their Internet of Things daily objects. The five selected interaction patterns substantiate the kick-start of our interaction pattern library proposal.

3.3 Analysis: Interaction Patterns for Internet of Thing User Created Application

Interaction in IoT user created applications could be classified in different ways. We distinguish physical environment interactions from desktop-based interactions. Generally, in an environment interaction, end-users or developers instrument the environment and thus most of the interaction focuses on instrument objects to become smart (patterns 1 and 2). In a desktop-based interaction, end users are busy with filling into pre-programmed templates or wire visual widgets inputs and outputs (pattern 3 to 5). We noted that for IoT user created applications; a combination of the two interaction classes might be needed according to the application to be built.

Pattern 1: Smart Object Augmentation And Association. This interaction pattern is used to augment an object in order to empower or extend its capability (more processing, networking, situation aware capabilities, etc.). The augmentation is done with smart making enabling technology such as tags, labels, speakers, actuators, or sensing chips. For example augmenting a table with a speaker so the table could "speak". [5]

In the Smart-Its-project [5], the concept of friend relation ship between objects was introduced. Users could augment two objects and specify their relation ship by doing the same movement pattern (e.g. shaking them together or waving them simultaneously). The friend relationship can be used to create different kinds of applications. Making such type of objects associations is close related to physical object composition when users compose object to activate the object group behavior (see cubelets[5] and siftables[6]).

Example: By specifying the friend relationship, end users could elaborate a desired behavior of their personal objects. The behavior becomes only active when this friend relation ship is satisfied. For example: end users could connect their car key and credit card with a physical proximity relation so their credit card could not be used with the absence of their car key. (See Figure 2). Users could also use this interaction to create a child monitoring application by attaching two objects, associated with a friend relation ship, to both the parent and his kid.

Fig. 2. Friend relation ship for smart object interaction

Detailed flow for application creation: Augment each object with a smart label and shake them simultaneously. As a result, an application creation template pops up on the screen of the user creation environment. The user has to specify the friend

[5] http://www.modrobotics.com/cubelets/
[6] http://alumni.media.mit.edu/~dmerrill/siftables.html

relationship between the objects (e.g. proximity) and the associated actions, application, and context to trigger the desired behavior of the objects.

Analysis: Object augmentation does not require system training and is easy and straightforward for creating simple applications. However, the programming paradigm is limited to consider events that could affect the object behavior in a specific context.

Pattern 2: Magnetic Poetry Interface. Description: This poetry inspired interactive application creation paradigm allows users to create applications in a way that takes advantage of the flexibility of natural language. It gives users the opportunity to build applications that reflect their way they linguistic envisage of the desired application, as opposed to requiring users to specify applications in terms of tangible devices.

Features: A graphical user interface for creating applications is augmented with magnetic cards, categorized in: what, where, when, and general, creates with its abstract vocabulary a poetic programming atmosphere.

Positive aspects: The user can express and combine concepts in a flexible but limited way. The restricted vocabulary allows easier system translation,

Limitations: Usually natural vocabulary based application requires huge translation efforts leading to solve conflicts (e.g. use of dictionaries).

Application Creation Flow: Magnetic poetry based descriptions are fed into the system by the end user, which, in turn, generates a specification that can be executed in a context aware environment (e.g. home environment).

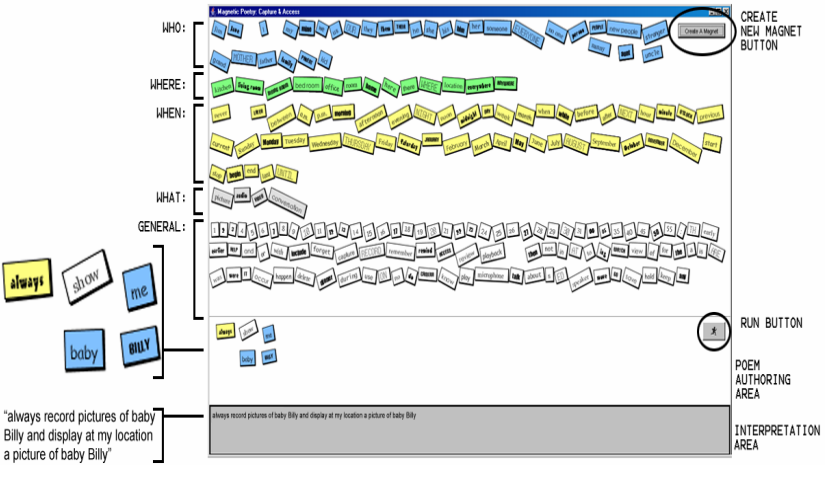

Fig. 3. Magnetic poetry [6]

Pattern 3: Pipeline Interaction. Description: Users can wire abstract concepts by linking their inputs and outputs of specific widgets in a graphical user interface. The widgets could represent multi-modal sensors and actuators, or components that are more complex.

Similar Paradigm: Workflow interaction,

Features: Low-level data transformation (filtering, threshold,) techniques and high-level data control mechanisms (synchronic function call, multicast, etc) are available at the same programming level (canvas).

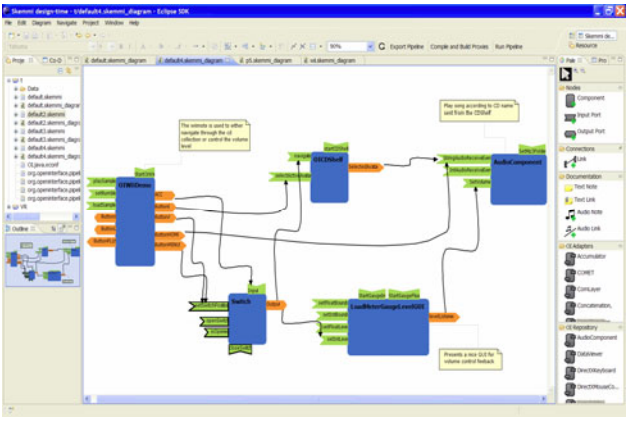

Fig. 4. Pipeline Interaction[7]

Positive aspects: Goal and task oriented creation paradigm is easy to comprehend by non-technical users

Limitations: The set of possibilities is limited and there is no support for collaborative design. This component composition technique requires technical knowledge of the components interface and behavior for fine-grained tuning of designed interactions. Illustrative examples are supportive used.

Application Creation Flow: Users can change iteratively concepts inputs and outputs. Documentation is attached to each component allowing easy understanding of components responsibilities, attributes, roles, and interfaces.

Pattern 4: Interaction by Example. Description: A user can visually inspect data, record desired behavior (e.g. complex gestures), uses it further as interaction pattern, and evaluate the effect runtime.

Features/Requirements: Signals inspectors e.g. used in oscilloscopes, computer vision techniques (such as OpenCV), and pattern matching algorithms (Dynamic Time Warping, five degrees-of-freedom gesture recognition) should be seamless integrated in an ready-to-use experience.

Example: The user performs an action, annotates its recorded signal, tests the generated behavior, and exports it to a supported tool.

[7] http://www.openinterface.org/platform/demonstrations

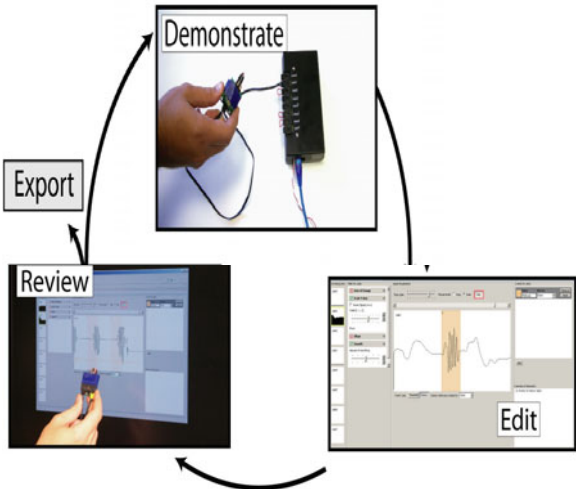

Fig. 5. Interaction by example[8]

Limitations: This application creation pattern is mainly applied for authoring sensor input. The demonstration is based on sensor data training and classification; where in some cases more than one training (demonstration) session is used.

Analysis: From a first analysis, there is a doubt how to apply the demonstration technique to recognize complex user activity requiring multiple data sources.

Positive points: seems perfect for single data source application, e. g pressing a force sensor.

Application Creation Flow: Users use a model to transform sensor inputs into application events, either discrete or continuous, by indicating thresholds or patterns on the incoming data. After that, they map events derived from sensor input on key presses or mouse events using the model, in order to operate a legacy application (e.g. map a wave gesture on the 'P' key to toggle playing/pausing in a media player application). Hence, the system will learn the demonstrated behavior for the demonstrator end user and will replicate the example when the same user will perform it.

Pattern 5: Tangible Metaphoric Story. Description: the interaction is constructed using tangible metaphors and stories.

Positive aspects: The Tangible metaphoric story allows end users to express their own meaning to interaction using tactile, visual, and metaphor embodied language. In addition, the tangible result permits a very fast funneling between detail and the whole with rich senses experienced. The metaphor brings to end-users an experience to support creativity [7].

[8] http://hci.stanford.edu/research/exemplar/

Limitations: It could be necessary to communicate cultural differences in advance or to take some learning steps in advance. Warm up sessions could be necessary to get used to the format in order to avoid resistance, hesitation to overcome.

Fig. 6. Tangible Metaphoric Story

4 Conclusion and Perspectives

The template we made allowed us to not only rethink the user environment interaction and enhance the user creation flow, but also to come up with a new interaction pattern that we experimented in our lab and we have a plan to make a functional prototype of them. The prototypes will be will be taken as input in the user research activities of the DIYSE project where expert and non-expert users will reflect on their effectiveness in their do-it-yourself social activities. The extended library will be presented in the conference.

From creativity point of view, the majority of patterns mentioned so far are best applied during the convergence phase of the creative process where ideas get concrete shape and designated interaction. We are currently working on patterns targeting the "fuzzy zone" of idea generation, the act of exploration for inspiration, and the desire for playfulness.

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