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Explorer le potentiel des interactions tangibles rotatives pour les Smart Watches

Investigating the Design Space of Smartwatches Combining Physical Rotary Inputs

Emeline Brulé
CNRS i3, Télécom ParisTech, Université Paris-Saclay
46 rue Barrault
75013, Paris, France
emeline.brule@telecom-paristech.fr

Gilles Bailly
Sorbonne Universités, UPMC Univ Paris 06, CNRS, ISIR
4 Place Jussieu
75005, Paris, France
gilles.bailly@upmc.fr

Marcos Serrano
Université de Toulouse, IRIT - Elipse
Avenue de l’étudiant
31400, Toulouse, France
marcos.serrano@irit.fr

Marc Teyssier
LTCI, Télécom ParisTech, Université Paris-Saclay
46 rue Barrault
75013, Paris, France
marc.teyssier@telecom-paristech.fr

Samuel Huron
CNRS i3, Télécom ParisTech, Université Paris-Saclay
46 rue Barrault
75013, Paris, France
samuel.huron@telecom-paristech.fr

ABSTRACT

Watches benefit from a long design history. Designers and engineers have successfully built devices using rotary physical inputs such as crowns, bezels, and wheels, separately or combined. Smart watch designers have explored the use of some of these inputs for interactions. However, a systematic exploration of their combinations has yet to be done. We investigate the design space of interactions with multiple rotary inputs through a three stages exploration. (1) We build upon observations of a collection of 113 traditional or electronic watches to propose a typology of physical rotary inputs for watches. (2) We conduct two focus groups to explore combination of physical rotary inputs. (3) We then build upon the output of these focus groups to design a low fidelity prototype, and further discuss the potential and challenges of rotary inputs combinations during a third focus group.

CCS CONCEPTS
• Human-centered computing → Interaction devices;

KEYWORDS
Smartwatch, wearable, eyes-free interaction, rotary input, focus groups

RÉSUMÉ

L’histoire des montres est pleine d’exemples utilisant une ou plusieurs modalités tangibles d’interaction comme les couronnes, les lunettes et les molettes. Pourtant les concepteurs de “smartwatches” ont seulement exploré un sous ensemble de ces mécanisme et surtout n’ont pas considéré la possibilité de les combiner. Dans cet article, nous étudions les possibilités offertes par la combinaison de plusieurs de ces mécanismes rotatifs en trois étapes pour les smartwatches. (1) Nous rassemblons une collection de 113 montres traditionnelles ou électroniques pour faire une typologie de leurs mécanismes rotatifs, (2) dont les combinaisons sont explorées et discutées durant deux focus groups. (3) Ces discussions nous mènent à développer un prototype pour discuter des potentiels et des défis des combinaisons d’entrées rotatives au cours d’un troisième focus group.

MOTS-CLEFS
Montre intelligente, objet connecté porté, interaction non-visuelle, mécanismes rotatifs, focus groups

1 INTRODUCTION

The history of watches includes numerous types of designs using a large variety of physical rotary inputs: bezels, crowns, wheels, and even pointing sticks. They may be used alone or combined. As watches are “cultural icons” [6], these aspects of their design are part of our cultural and visual knowledge. In addition to being culturally significant, physical rotary inputs have several advantages. For instance, they allow for continuous and spatially unbounded motions [14]. They also provide spatial landmarks easily reachable and memorizable (e.g. a quarter turn) which can be used eyes-free [20].

There are a few studies using a bezel for interaction (e.g., [23, 25]). Kerber et al. [9] have investigated usability and preference regarding
the use of crowns and bezels, while others have explored twist gestures [22, 24]. Simple rotary interactions are being integrated in commercial devices such as the Samsung Gear and the Apple Watch, which respectively use a bezel and a crown, for scrolling or swiping. Despite this, we argue that the previous research has not explored in detail the design space of physical rotary inputs for smartwatches, as it has largely ignored the combinations of inputs so frequent on traditional watches to parameter them or to make calculations. We argue that combining rotary inputs can provide more opportunities for eyes-free or remote manipulation: not only does it enable to design new gestures but it could also provide more expressiveness by mapping information to multiple inputs. To inform future designs and take full profit of the interaction advantages of this type of input, we need to investigate this design space.

We propose an exploration of the design space of physical rotary inputs in three folds. We first study a collection of 113 traditional watches and identify three types of rotary inputs to take into account when designing the hardware. Building upon these findings, we describe a design space for the combination of physical rotary inputs and conduct two focus groups to explore the potentialities of this design space. Multiple design combinations enriching the input vocabulary emerge from the focus groups but participants converged towards a double stacked bezel design illustrated Fig. 5 because (1) they can easily switch from one bezel to the other or (2) use both at the same time. They also foresaw (3) that it allows a rich gestures set and (4) envisioned multiple scenarios benefitting from its use. We then build a low fidelity prototype of this double stacked bezel design and further refine our understanding of rotary inputs combinations through a third focus group.

Our main contributions are: (1) a survey and a design space for physical rotary inputs on watches; and (2) insights and design challenges regarding the possible hardware combinations of two physical rotary inputs.

2 MOTIVATIONS AND RELATED WORK

Previous studies suggest that smartwatches [12, 17] or bracelets [10, 13, 15, 16] are useful for frequent actions (e.g., notifications, remote control of a media player, activity logging) because they can support subtle micro-interactions [2, 3]. Micro-interactions enable users to quickly access digital information in situations of mobility, while interacting eyes-free or with peripheral attention. However, implementing robust and useful micro-interactions is challenging: voice commands can be error-prone in noisy environments, and raise privacy issues; simple physical gestures [7] are often the only appropriate as shortcuts for a limited number of commands; on-body gestures [4, 18] raise social acceptability issues and their implementation remains difficult. For such scenarios, several studies suggest that physical inputs, rotary or not, are more usable or preferred by users [8, 20], but only few of these studies focus on smartwatches [9, 23, 24].

Several projects augment smartwatches with mechanical inputs including panning and tilting [22], buttons (e.g., Pebble watch), and rotary physical inputs [9, 23, 24]. In particular, physical rotary inputs have several advantages. (1) They support spatially unbounded motions, which allows for the continuous manipulation of any kind of variables [14]. For instance, interactive crowns are preferred to touch for scrolling a list [9]. (2) Users can easily reach and memorize spatial landmarks such as half or quarter turns because they allow positional control through direct manipulation, while enabling to change velocity in an intuitive and efficient way [20]. (3) Moreover, their circular design favors eyes-free interaction [20]. For instance, Xu and Lyons [25] propose to use a rotary bezel for setting a smartphone mode while eyes-free.

Despite these advantages, only few commercial smartwatches (the Samsung Gear and the Apple Watch) use a physical rotary input for scrolling a list or for swiping from screen to screen. However, none of these works have explored combinations of physical rotary inputs while the following study reveals that many traditional watches exploit this input.

3 PHYSICAL ROTARY INPUTS ON TRADITIONAL WATCHES

In this section, we study traditional watches to inform the design of smartwatches. While similar approaches have been proposed to study the aesthetism of smartwatches [1] or their potential uses [12], we focus on interaction and more precisely on the use of physical rotary bezels. We identify design dimensions related to rotary inputs, and present the insights gathered through the survey on their combinations.

We collected and classified 113 examples of watches using physical rotary inputs (see Fig. 1 for an example) by interviewing 2 watch designers with more than 5 years experience (one working on luxury watches, the other on smart watches) and 4 watch collectors.

Then we looked for detailed information on the history of these design features. We decided to focus on circular watch cases (i.e. excluding rectangular ones), to include rotating bezels in the design space. However, wheels and crowns can be found on rectangular watches. We also included a conceptual haptic watch illustrated Fig. 1-d, which makes use of two physical rings to display the hour. From this collection, we identified four dimensions related to rotary inputs that we now describe.

3.0.1 Type of rotary inputs. One of the authors annotated the physical rotary inputs of the 86 remaining examples (after removing the rectangular ones) with keywords to identify common features (e.g. "one crown, top"; "two crowns, right, bezel"). We then identified three main types of physical rotary inputs: crowns, rotating bezels.

Figure 1: Examples of watch combining different types of rotary inputs
and wheels. Among the 86 watches, 84 had at least one crown, 10 had a rotary bezel and one had a wheel.

The three types of rotary inputs are illustrated in Fig. 1 and described below:

Crown: They have been used since the XVIIth century for winding mechanical watches or to set the time. Today, they still remain the main rotary input for both traditional and smart watches. Over time, crowns have moved from the top of the watch (Fig. 1-a) to the right and/or left side (Fig. 1-b).

Wheels: These are present on multi-purpose watches, such as maps or radio watches. They are embedded in the watch case.

Bezels: These have the size of the watch. They were initially used for measuring time or to make calculations, as a slide rule. Rotating bezels are quite common on professional watches.

3.0.2 Size of rotary inputs. In our watch collection, Bezels have an average size of 42mm and crowns of 6 mm. But in the conceptual haptic watch (Fig. 1-d) or in radio watches, bezels and wheels can have intermediary sizes.

3.0.3 Style of rotary inputs. We also observed that bezels (rotary or fixed) may be used to convey tactile information (with either 4, 6, 8 or 12 landmarks), and may be toothed or slanted to ensure a good grip.

3.0.4 Combination of rotary inputs. 67/86 of the watches surveyed had at least two types of physical rotary inputs. Rotary inputs can be combined in the watch case: For instance, the watch presented in Fig. 1-b has two crowns in addition to the bezel. They may also be combined to each other: For instance, the wheel is clamped in the bezel in Fig. 1-c. The majority of these watches (48) combines two or three crowns, while the others combine crowns and bezels (18) or bezels and wheels (1). Thus, there are combinations of rotary inputs that have not been explored yet.

3.1 Discussion

From the interviews, watch designers and collectors reported that watches using wheels and/or bezels inputs are quite rare ("Your typical watch have a single crown"). They underlined that this rarity was not due to usability, but rather to user needs. Most users of regular watches were only interested in getting and setting the time and thus miss out on promising design.

The increasing amount of functionalities on smartwatches, we argue that it is worth exploring the potential benefits of combining physical rotary inputs. Beyond the advantages of physical rotary inputs listed above, combining them might increase the expressiveness without consuming more screen real-estate or impairing precision, as well as foster eyes-free interaction. In line with traditional watches design, we now explore the design of smartwatches combining two physical rotary inputs.

4 EXPLORING THE DESIGN SPACE: FOCUS GROUPS

There are many ways to explore design spaces of devices. We choose to use a focus group method because it is particularly suitable to gather experts opinions on multiple diverse solutions. Each expert can very quickly generate and explore solutions to difficult design problems while other approaches (e.g. comparative evaluation) can only focus on a small part of the enormous design space and thus miss out on promising design.

We conducted two focus groups with design experts. The focus groups were videotaped and annotated afterwards by one of the researchers. The transcript was then open coded and analyzed thematically. The goal was to (1) validate with designers the benefits this class of inputs, (2) identify the most promising configurations inside the design space, and (3) generate interaction principles and scenarios taking advantage of these configurations.

Participants: Our two focus groups were each composed of eight participants (age 23 to 38, M=28 years, 16 participants in total). 12 of them were designers (User Experience, User Interface or product designers, including two working on wearables), and 4 were HCI researchers. Two of them used a smartwatch regularly, two from time to time, eight used traditional watches. The others did not use any watch.

Design cases: To support the discussion, we designed 9 cases that cover the combinations of three rotary input type (bezel, wheel and crown). The watches cases are illustrated in Fig. 2. Their sizes are closed to what could be expected from a commercial smartwatch, and they may be used as a support of interface paper prototyping. We designed 24 elements that could be used either as a wheel, bezel or crown: they come in 4 sizes (6, 18, 30 and 42 mm—standard deviation 12) and 6 styles (toothed, slanted and with various tactile landmarks). However, not all combinations are possible without impairing usability: in our case, we let the two focus groups rule them out.

Procedure: We first explained that our goal was to collect feedback on the design of new smartwatches, for which we were considering different form factors. We explained that all our watch cases were low resolution prototypes, and that they should imagine the final commercial version. We also indicated that we wanted to...
explore eyes-free use. The instructor invited participants to think aloud, discuss and freely test combinations. After 15 minutes of free interactions, the instructor asked them to express their preferences, which were discussed for 15 more minutes. Then she invited the focus group to engage a discussion for 20 minutes on potential gestures for their preferred design. She did not intervene, except to seek clarification.

### 4.1 Results

#### 4.1.1 Device

Participants cooperated and created both potentially usable designs. They also voluntarily created non-realistic designs to trigger new ideas and discussions as shown in Fig. 3.

Participants proposed combinations involving three physical rotary inputs, or including a button on top (as simulated in Fig. 3-d). They discarded the use of three physical rotary inputs as too complex. All participants proposed various combinations of wheels and bezels of different sizes (Fig. 3-b&c), to expand the number of controls. However, these could not be used simultaneously, which limited their use to applications benefiting from the eyes-free use of two functions (such as a music player, for volume and songs).

Nine participants were also interested in the possibilities of a large wheel augmented with a crown (Fig. 2-f), in particular for remote interaction with a two levels menu. However, the other seven found this model too limited for interaction, and outlined that it would be more difficult to operate with a single finger, at the contrary of bezels.

Both focus groups gradually converged towards a double stacked bezels prototype (Fig. 5) through two different pathways. The first focus group’s participants focused on general interaction principles and argued that the size of the bezel allowed for more control and sensitivity than the wheels and crowns (“I’ve been playing with [the bezel], I think I can easily distinguish twelve landmarks—I’m not so confident for the crown. And it requires to use two fingers”). Two people in the first group argued that rotary inputs of different sizes (e.g. crown and wheel) would probably be interpreted as having a different span, while same size inputs could be configured on a case-basis (“if you take this one [i.e. Fig. 2-f] you’re going to suppose that the wheel has a larger span than the crown, that the crown can only be used for details”). The rest of the participants agreed, which led the group to exclude all the designs other than the double stacked bezels. Two other participants also pointed out that combining two bezels enables the same gesture to be performed on one or the other bezel, or with both very easily (see also Section 4.1.2), opening opportunities for supporting novice to expert transition in using menus. Finally, they foresaw the advantages of a double bezel for all kind of selection: two participants argued the first bezel can be used to select a set of item, the second bezel to select an item within this set (“if you think about it, almost every app we use daily is a two, maximum three, levels menu”). With experience, they foresaw users could select a large number of items while eyes-free.

As for the second focus group, the participants rather focused on the scenarios enabled by the different types of combinations. They emphasized the playfulness and expressiveness of tangible controls and that it was well adapted to everyday, situated interaction. Four of them were particularly interested by its use as a remote (eyes-free) controller (“We’ve got so many remote and controllers now! It’s...
were usable. As for wheels, they all preferred the two smallest sizes
wheel and a bezel (Fig. 2-i), and a double-stacked bezel, because
All participants agreed on
(“the second focused on use cases (e.g. a music app, smart home
choosing the apps, the other for navigating within the app
bezels turn at the same time
on interactions (e.g. the subsequent proposals di
justi
interactions on their preferred model (two stacked bezels), which
minutes of the focus group, the participants discussed potential
got worse than it was a few years ago, with the TV and satellite
and DVD player remotes. And I really like tangible controls, but we
need something more complex than buttons, and this kind of sliders,
I’d be curious to use them”). The whole group discussed the potential
for controlling the environment, rather than just the watch. One
example was scratching the music currently playing, or controlling
a slides player. They hesitated longer between a model using a
wheel and a bezel (Fig. 2-i), and a double-stacked bezel, because
two participants argued that on both these models the two inputs
can be used in the same movement, rather than one after the other
(“It might be more practical, to have them separated. Maybe the
mapping would be more intuitive. But that’s definitely less practical
for a power user”). They however settled for a two bezels design,
emphasizing that the amplitude of the movement would enable
for more precise control than the other rotary inputs (“I definitely
prefer the two stacked bezels. You’re less likely to manipulate them
by mistake”). Although all participants tried to create designs using
middle size crowns, they all agreed that only small crowns (6mm)
were usable. As for wheels, they all preferred the two smallest sizes
(6 and 18mm).

4.1.2 Interaction on the preferred model. During the last 20
minutes of the focus group, the participants discussed potential
interactions on their preferred model (two stacked bezels), which
justified their choice.
Circular menus: The first idea in both focus groups was to use
the bezels to explore a circular menu: each bezel would be assigned
to a menu level. While both groups thought of circular menus,
the subsequent proposals differed: the first focus group discussed
on interactions (e.g. “you could have something different if both
bezels turn at the same time” or ‘one of the bezel could be used for
choosing the apps, the other for navigating within the app), while
the second focused on use cases (e.g. a music app, smart home
remote control, game controller) and challenges regarding different
navigation needs.
Gesture shortcuts: Participants proposed four classes of gestures.
All participants agreed on continuous rotation, whereas the gesture
acts as a slider and can be used for setting the hour. All participants
agreed on the use of swipe (Fig. 4-Top), as a very short gesture
to the left or to the right, that can be used for navigation. Fifteen

participants agreed on the design of a pinch gesture (Fig. 4-Middle)
involves two fingers, one per bezel, pushing in opposite or similar
ways. Finally, eleven participants agreed on the use of returns (Fig. 4-
Bottom), as a gesture starting from the top and quickly going to a
given position and then back.

Touch input: Five participants proposed to combine touch inputs
on the screen with tangible inputs. For example, in a calendar app,
the day or the hour could be selected by a touch input on the screen,
and then be set using a bezel swipe (or a wheel on a rectangular
watch). Three participants also proposed that the bezel itself could
be touch sensitive, so that an input could be confirmed at the end
of the bezel rotation.

To sum up, participants identified several combinations of phy-
sical rotary inputs, but the only one they agreed on was the double
stacked bezels. Regarding the interactions with this watch case,
they proposed a menu system, a set of gesture shortcuts as well an
interaction technique combining touch and gestures.

5 PROTOTYPE

The outcome of the focus groups informed the design of a prototype
called RotaryWatch illustrated in Fig. 5. This prototype is mainly
intended to collect reactions and gather new insights on potential
scenarios (including eyes-free interaction).

Device. RotaryWatch is a circular watch with two stacked bezels.
The top bezel is slanted, while the bottom bezel is toothed, to ensure
a firm grip as the contact area between the finger and the bezel is
smaller.

The watch case width and height are 42mm, which is similar
to traditional watches and current commercial smartwatches. The
RotaryWatch’s depth is more important than traditional watches
due to embedded electronics (which can be reduced on a high-
fidelity prototype). However, the bezels’ height is realistic.

The angular positions of the bezels are acquired by two rotary
encoders, wired to an Arduino board, powered by the computer
through a USB cable. The graphical interface is shown on the com-
puter screen, or on an OLED display of 1.5”, which can be fixed to
the forearm.

The graphical interface is controlled by a NodeJs server and
by two controllers. The first tracks bezels’ rotation. The second
recognizes the gestures (return, pinch and swipe) illustrated Fig. 4.
These gestures are defined by three features: the angular amplitude,
the rotation direction and time length.

Interaction and applications. We distinguished gestures dedicated
to the whole system (e.g. sound) and gestures for in-app interac-
tions (e.g. list navigation). Whole system gestures are performed by
interacting simultaneously with the two bezels. For instance, the
system sound level could be set by moving both bezels continuously.
In-app gestures use only one of the two bezels. We designed three
use cases (music player, menu, map) to exemplify potential uses.

6 EXPLORATORY EVALUATION

Through a focus group supported by the use of this prototype, we
aim at gathering professional designers’ point of view on rotary
inputs combinations for smartwatches. We chose to gather this
qualitative feedback from experts rather than quantitative data, as
we focus on usage (rather than performance comparison). Focus

![Figure 4: The swipe, pinch and return gestures proposed by our participants, as described in the findings of our focus groups.](image-url)
One aspect emerging from this focus group is the versatility of the device. The participants described 21 scenarios for which they perceived that our proof-of-concept would be preferable to a single rotary input and to current touch-based interaction. 8 of them were related to the smart home (e.g., controlling smart lighting or television), 5 to activity tracking (e.g., setting the chronometer, itinerary planning), 3 to smart cars (e.g., control of glasses), 2 to their professional activities (e.g., controlling 3D objects) and 2 to gaming. Additionally one participant outlined that using RotaryWatch could make other applications playful: he suggested that it could be used for lock and unlock a house or a bike using a combination of gestures (“like in spy movies. It would be so much more fun that way”). The four other participants agreed on this.

Eyes-free: In many scenarios proposed (e.g. gaming, professional, and smart cars applications, remote control for home appliances), participants envisioned the watch could become a controller for exported screens, suggesting these rotary inputs are well suited for eyes-free interaction. Participants also debated whether 8 or 12 landmarks could be reached eyes-free on each bezel. Although a majority (5/6) argued that 8 landmarks would be better manageable and can be described as would a direction be (e.g. “North”, “Southwest”), this should be further tested. In any case, this opens multiple possibilities for eyes-free interaction: there should be at least 64 combinations of landmarks reachable.

Style: One participant working on luxury watches underlined that this form factor could generate new aesthetic propositions (by the superposition of two different material for instance) and be well received by designers of high-end watches. He also pointed out that people valuing watches are interested in complex and unique mechanisms, and that this could the opportunity to design a specific UI—just as watch faces used to be work of art. The other participants

Figure 5: (a) The three implemented applications and the envisioned device. (b) Our proof-of-concept, a watch using two stacked bezels. The bottom bezel is toothed, the top bezel is slanted. (c) For demos, we used a deported screen when visual feedback was necessary.
agreed but also underline it would require the development of new skills in this industry.

Limitations: The main drawback was the perceived complexity of the device. A UX designer participant was concerned with how to convey the use of each bezel and their combinations. Two others argued that it would mainly appeal to expert users, although they also underlined that it could support novice to expert transition (by first interacting with only one bezel, and gradually learn to use the second one).

7 DISCUSSION

A survey of traditional watches enabled us to identify dimensions of the design space of physical rotary inputs. It provided a useful structure to help focus group participants to explore and generate new devices and scenarios. The number, diversity and richness of the details of scenarios they proposed tend to confirm that combining rotary physical inputs is a promising design space to investigate for interaction with smart watches. The scenarios they envisioned were highly contextualized and often involved multi-tasking. The focus groups confirmed our motivations: designers identified eyes-free use and a higher number of shortcuts as a primary benefit, and spatially unbounded motions as a way to customize sensitivity. Our participants also suggested that (1) these aspects would be beneficial for accessibility and that (2) physical rotary inputs not only consume less energy than touchscreen, but they can also generate the energy necessary to the functioning of the device. This might be especially useful for bracelets such as Fitbit, which do not have a tactile screen. (3) These inputs can also be used with, or in parallel of, more traditional inputs techniques, such as voice or touch. Interacting with physical rotary inputs does not occlude the screen. (4) Finally, it can reinforce expressiveness in several applications (e.g., in manipulating various kinds of data, from the time to audio content). Albeit use of rotary inputs would not be indicated on all types of interactive bracelets, it seems to be an interesting lead for people working on accessibility, but also, surprisingly, on high-end watches. Combining rotary inputs may also be beneficial for other devices using this type of physical inputs during complex tasks (e.g., Mental Canvas). Indeed, it adds a dimension for interaction.

A critical point raised during the focus group was the learning curve in using a device combining rotary inputs. However, the designers also discussed several strategies to address this: Learning to use one input at a time, customizing gestures, sensitivity and applications. Gesture-based teaching methods such as Marking menus [11] can also guide users step to step for selecting commands. This would need to be evaluated with end-users, rather than with designers.

8 CONCLUSION AND FUTURE WORK

To sum up, the design space of traditional watches enabled us to identify three main types of physical rotary inputs, and their combinations, describing a design space for physical rotary inputs for smartwatches. Our first step was to explore this design space through focus group, and proposed to specifically explore a two-stacked bezels watch, RotaryWatch, which is, to our knowledge, a new design proposition. Our second step consisted in organizing a second focus group with experts designers with elicited the design challenges and opportunities for smartwatches combining physical rotary inputs based on the proof-of-concept. It focused on one device, but many of their insights (e.g. sensitivity) may apply to other combinations identified earlier in the exploration process, or to the use of a single rotary input.

Future work should focus on: (1) Evaluating the usability of rotary inputs with users, and in particular of eyes-free use. We note that it would be too demanding for users to try every combinations of the two bezels. The evaluation could consist in a specific subset of shortcuts using both bezels. It should also be performed while walking or while doing another activity; (2) Exploring users’ preferences, by implementing a few scenarios on both our prototype and a touch-based smartwatch, and enabling their use outside of the lab; (3) Investigating combinations with other interaction modalities, and touch in particular, both for this prototype and on commercial watches using rotary inputs.

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REFERENCES

Symposium on User Interface Software and Technology (UIST ’12). ACM, New York, NY, USA, 123–130. DOI: http://dx.doi.org/10.1145/2380116.2380134


