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Abstract
Local Sensor is a direction and distance tracking application using low power wireless connectivity. It enables new mobile user experiences bridging the physical and digital world. There are lots of challenges in user experience design since it is new for most end users. This paper introduces how the user experience design was conducted to make local sensor an appealing feature for mobile phone users.

Keywords
Local interaction, Directional UI, Local connection, Indoor navigation, Seamless navigation

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
Local sensor technology is built on top of some local wireless connection. It can detect direction and distance of another local sensor device within the range of 100-500 meters depending on transmission power.

The following technical advantages make local sensor a good platform for mobile device and service innovation.

1. Very low power consumption. A button cell battery in a local sensor tag can last for 1.5 years.
2. It is peer to peer positioning and no GPS or network connection is needed.

3. It is two-way communication with small radiation, which is only 1/1000 of a GSM mobile phone radio.

From the online survey statistics, we found the top use case is that users want to know how far it is from a special tag which they can put on their keys, kids, pets or anything else they want to keep track of. (Figure 2)

And the 2nd most popular use case is an automatic device security lock when users are far away from their phones. The popularity of this use case was unexpected, but there is an obvious trend that information security issues have become more and more important for end users.

Design process

Key use case identification

Local sensor is based on cutting-edge technology but we tried to prevent local sensor from becoming a technology-oriented project. End users were involved in the design conception phase from the very beginning. We easily came up 180 use cases in the co-creation workshop. However, because of limited resources, we voted internally and visualized the top 20 use cases. These were then subject to an online survey based on 500 users in UK. Figure 2 shows how the concept visualization looks like.

The third most popular case is about local sharing and interacting with other devices. Based on above user study, we summarized the 2 primary use case categories as follow:

1. Click to find: Locating people and objects around you.
2. Point to do: Point to a target for local interaction based on physical location of real life objects and
Agile design process combining user study  
According to the requirements of key use cases, we started conception and decided to use traditional and intuitive metaphors, e.g. radar, compass, and indoor map, in UI design to hide the technical complexity of local sensor. For such new user experience exploration, we did not make detailed UI specification and started from a basic UI framework. UI design refinement, mini-scale user testing, and software implementation were conducted simultaneously.

**figure 3.** The 3 main views of local sensor application.

The design principle is to use daily objects in the user interface to make this technology more humanized for the end users. Figure 3 shows the radar, arrow and map views of the application. Cartoon style avatars with different colors and frame shapes are used to make the views less technical. A list view, which is common in mobile phone user interface for item handling, is also provided in order to keep the UI consistent with the native user interface. The user study results show that most users still tended to manage the items in the list view which is familiar to them.

Navigation UI is the most challenging part because lots of information needs to be visualized in the same view during target finding, e.g. distance, direction, signal quality, and obstacle information. Because users can not pay attention to several UI elements in the same time, a single rich information arrow was designed to show all relevant navigation data.

Figure 4 shows how different information is mapped to different arrow properties. Color coding: red means near and green means far; Size coding: Long/thin means far & Short/thick means near. If there is an obstacle in between, the arrow will be curved since it is not pointing directly to the target. If the signal strength is weak and the direction is not 100% accurate the arrow will become a dotted line.

**figure 4.** The ways how navigation information is mapped to different arrow properties.

SVG format vector graphics are used to enable smooth color and shape transition of the arrow. Figure 5 shows how the arrow properties change when approaching the target. We expected that too much information is coded to the arrow and some property changes need to taken...
away. However the user study shows that large amount of information is not a problem if it is meaningful and intuitive in this case all the users could easily understand the meanings of arrow property changes after trying it. Moreover even though there is only an arrow on the screen, a couple of users almost ran into the wall when navigating to the objects during the user study because of limited attention. It is interesting that a user even proposed that a notification “Mind your step!” should be on the arrow view as a reminder.

We also worried about the color coding because of cultural differences so we used traffic light color metaphor which is common globally. The cross-culture user study also shows that this is a generally understandable solution.

**figure 5.** Arrow properties changing when approaching a target.

As shown on figure 6, to enable point to point navigation, we also tried a seamless navigation experience design. It switches from outdoor map view to indoor map view and then to arrow view when approaching an indoor target from outside. However, many users do not like the indoor map in between and prefer the simple way to jump from the outdoor map view directly to the arrow view. One user mentioned,“If I am lost in a shop, I would rather ask people for the right direction instead of checking the map because it is difficult to read”. This is an interesting finding which means the indoor navigation should not copy outdoor navigation user experience design because of the contextual differences.

**figure 6.** User interfaces for seamless outdoor-indoor navigation.

**Conclusion**

Old user interface metaphors are used to design user experience of local sensor application. The user study results are very positive, but we also learnt that indoor open space navigation are so different from outdoor navigation and different interaction design is needed. In the next step, we will run a large scale pilot to investigate more details in the real context to find better solutions in this new area, and also try to develop some relevant mobile services, e.g. mobile lost and found service, based on the lessons learnt from this design and user research practice.