Sentinel: Universal Access to Ambient Devices

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Abstract

We suggest that with the advent of ambient devices, pervasive computing systems, mobile user-devices and the associated move towards accessing mobile information the HCI community has a perfect opportunity to influence the design of mobile interfaces early in their lifecycle. The Sentinel activity (part of the wider **proXimity** project) seeks to decouple the interface (siren) from the ambient object (fire alarm) and place that interface with the user's mobile device (PDA, 'Braille n Speak'). The user device is specific to that user and so too is the interface; however, the problem of static interface creation (normally by sighted designers) still exists. If we are truly to make access to the real world a universal activity the presentation of the interface (buttons, sliders, etc) must be separated from the functionality of the device, and therefore the functionality the interface is required to fulfill (data and control instructions). Sentinel aims to address this issue by using functional prototypes (written in XML) to separate these two areas. It does this without specifying the type of interface-control (button, tick-box, etc) required and instead delegates the interface-control presentation task to the user-device which can more individually react to the accessibility needs of its user.

1 Introduction

The 'Sentinel' activity attempts to make interaction with devices in real-world environments accessible to visually impaired users. As an activity Sentinel is principally focused on making travel and mobility in complex urban and internal - inside buildings - environments easier. It does this by providing universal access to objects - known as ubiquitous or ambient devices (Cooltown, 2003) - that would normally assist mobility but are uni-model with regard to sensory perception - normally tailored to visual perception. We theorize that universal access to ambient devices does not exist because the user interface and the device functionality are conjoined. Further, a stable and useable interface specification between these parts does not exist and this means that separation cannot occur. It is our objective to address these issues by separating the user interface from the ambient device completely. We then facilitate the creation of an interface method to convey control, functionality, and information from ambient device to user interface. Significantly we address universal accessibility by focusing not on the human computer interface itself but on the interface between the ambient device and the method of controlling that device. To do this we use developed technologies like Bluetooth, Infrared, and GPRS, and developing technologies like the Grid, and the Semantic Web. In this way we encourage different developers and manufacturers to support access to their devices by all user modalities just by implementing a simple interface.

1.1 Motivational Example

How can a blind individual withdraw money or get a balance from an Automatic Teller Machine (ATM – also known as a 'Cash Point')? Simply, they can't. If I wish to enter the Museum of Modern and Contemporary Art in Nice (France) to see an exhibit by the artist 'Niki De Saint Phalle' and I'm English and sighted then I can withdraw money because the ATM changes languages based on the information stored as part of my account. This is only possible because the text needed for the interaction is not 'hard-coded' into the compiled ATM software. The interaction modality (visual) is however unchangeable because designers assumed the user of the ATM would be able to see. In the 'Sentinel World' we don't make this assumption, if I'm blind and need some Euros to pay for my entry to the museum I just stop at an ATM. My device builds the interface to the ATM based on descriptions it finds for this ambient device on the web, all the questions asked and functions available are made by me through the mobile device and it's semantic web interface. Once complete my mobile device transmits the final instruction to dispense 20 Euros and a receipt, to the cash point, and my money is dispensed.

2 Sentinel

Complex and unfamiliar internal and urban environments can cause confusion and disorientation and so be difficult to traverse. Problems faced by both sighted and visually impaired travelers are similar when the environment to be traversed is unfamiliar and signage is complex. Many solutions have been proposed to try to elevate these problems within the visually impaired community - as orientation and navigation are particularly difficult for this group of travelers - but problems still remain. The Sentinel activity (part of the wider **proXimity** project) aims to use developed and developing technologies to solve mobility problems faced by individual travelers. The activity can only do this by encouraging the release of ambient devices into an area and providing universal access to those devices. We theorize that this Universal Access to a real-world environment can only occur if there is a physical separation between devices in the environment and the user's interface to those devices. We also propose that real progress can only be made if all devices conform to an interface standard such that any user can interact with any device. In this way the control of many desperate and disjoint ambient devices can be tailored to the individual needs of a user. The activity in effect creates a semantic web of ubiquitous devices with one user specific control interface to all devices, and with computationally intensive jobs processed by the grid.

2.1 Universal Ambient Networks – Addressing Single Focus Systems

Through our work on the activity we have become aware that single focus systems exist because the user interface and the functional parts of an ambient device are conjoined such that just one user modality is supported and one system functionality is addressed. Consider the example of a lift, in which a dyslexic user may have difficulty choosing floors and accessing lift functions because the lift user interface (in this case an LCD display) does not support their needs. Or the problem of how to notify a deaf person working in their office that there is a fire when the user interface to a fire alarm is only a siren. When mainstream computer systems where initially developed the overriding aim was focused on the creation of a computing resource and not on the interaction of humans with that resource. Designers thought that they had overcome so-many problems in the creation of computing resources that users would be thankful just for the computational ability (and they where). However, as systems became more complex and machines spread to the desktop to be operated by non-technical users, interaction with these machines became more of a concern. Finally, the accessibility to these systems by users who may not find monitor and keyboard to be the most effective means of interaction is now being investigated (Novick & Scholtz, 2002. Dix, Finlay, Abowd, & Beale, 2002). Some systems have been suggested (without much success) that try to alleviate some of these accessibility problems by dynamically generating complex user-interfaces based on simple design protocols (Siebra & Ramalho, 1999. Greenhalgh et al., 2002. Mitrovic & Mena, 2002). We decided to take a lesson from these systems and conventional Human Computer Interaction (HCI) design heuristics that supports a separation between the user interface and the code that implements the functionality of the application. This is ably demonstrated in the Mozilla Graphical User Interface (GUI) implementation (MozillaOrg, 2003), which allows a different `Look and Feel' to be used over different applications. By this separation universal access to applications can be accommodated because the interface can adapt to the user without the need to change any part of the other functionality (MacKay, 1998). Simply we offer the argument that this should also be the case with ambient or ubiquitous devices. However, we extend this rubric further by separating the ambient device into a computational device (within the environment) and a user interface device (specific to the user). In this way human computer interfaces within ambient systems can cater for multi-model sensory user interaction and multiple device / system functionalities.

2.2 Overview

Sentinel uses a combination of the real world environment, information about the local area, and services provided by device manufacturers to generate dynamic personal interfaces to ambient systems. Because the interface requirements for control of real-word systems and devices (like VCRs, elevators, etc.) are simpler than those used for general all purpose computing solutions reasonably intuitive interfaces can be created 'on-the-fly'. Consider our system with regard to Figure 1; in our first panel we see an elevator in use without the aid of Sentinel. The elevator is an older model and has just a push button interface, we can see that two individuals wish to use the elevator however because of its limitations the visually impaired user cannot as the interface (call buttons with light to signal that the elevator is on it's way) is inaccessible. Even if he could find the call button (in meters of wall space) he would not be able to tell if the elevator has accepted his request and is on its way. Next we see a depiction of the Sentinel activity in place, the elevator has been augmented with an Infrared device which interfaces to the elevator control panel and transmits information about the elevator status and the devices own identifier (as a 64 bit number sequence). The users have devices personal to them, in this case a Nokia 3G mobile phone and an augmented "Braille'n'Speak", so now the hardware for the elevator is independent of the user. Each system also has additional software to facilitate connection to the web and generation of the interface. Once the user device has received the identifier from the ambient device it is passed '`A`' to the `local` web server specific to that area (in this case it's 130.88.45.65). The identifier is found using the **proXimity** real world - virtual world resolution and definition services. This system provides services that automatically search for explicit and related (context and type) hypertext resources '`C`' and '`B`', control and display information, and pointers to where this information lays '`D`'. In effect the local web server hives off support for certain devices based on the device creators instruction and ability to provide the '`service`'. This service is a set of XML documents that inform the '`user device`' that interaction is required and what the components of that interaction should be. However these components are not control specific (like button, slider, etc) but are in-fact similar to those data types found in typed programming languages (like int, real, string). We augment these types with a command type (which specifies that a return value or cluster of values should be returned) and a range type (which specifies that a standard type like int should have a selective range – slider or dial). Once sent to the user device '`E`' the interface is created for interaction based on that device (audio only etc) and the users preferences (I like sliders not dials). The layout is not controlled by the designer but by the order of the markup in the XML document. The ambient device designer must add a tab-order of importance to the markup in this way the information may be rendered (in whatever fashion) based on the order the markup is received however the user may choose to disregard this and render in the tab order and therefore the level of importance. In this way the interface may not be visually appealing but practical and functional from an interaction perspective. All interaction is between the '`user device`' and the '`service`' (paths '`F`' and '`E`') however once the service considers that the interaction is complete based on its discourse with the user, control information is sent to the user device and from there to the ambient device (which will return its identification with an acknowledgement of the control information).

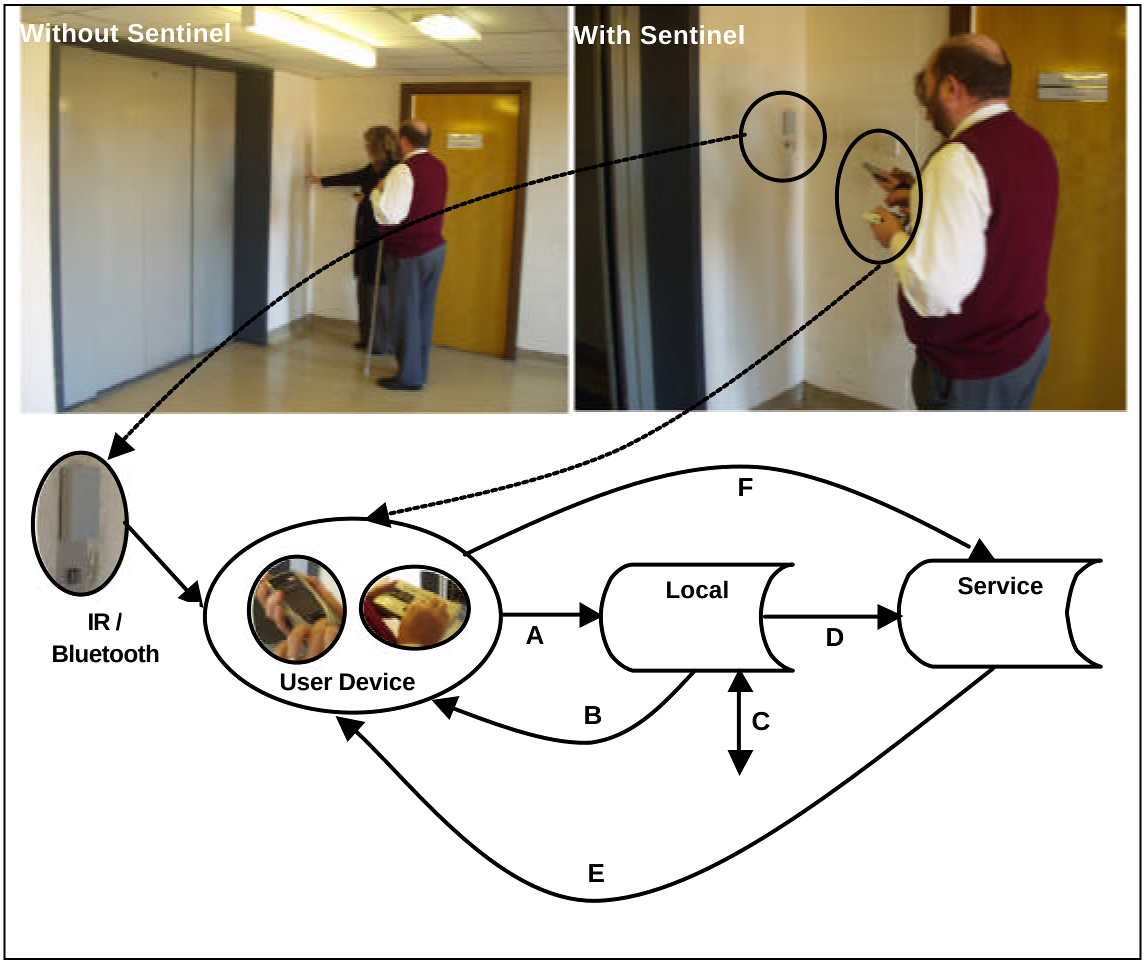

Figure 1: Sentinel Interaction

2.3 Issues

There are some issues that need be addressed with regard to Sentinel; we see these as concerned with movement and control. Movement through and around interfaces may seem less important than the activity of the interface itself however problems exist when there is limited screen real estate. Perception of information and control options is limited on small screen devices and audio only devices and therefore navigational rhetoric is very important (Goble, Harper, & Stevens, 2000). Also the control mechanisms for ambient devices need to be flexible yet predictable and so questions exist as to the best control methodologies to use. Should soft keys be used (reducing screen real estate) or hard keys (removing flexibility)? How do we address control in audio only systems without overloading the user? We also envisage problems with regard to the move from a manufacturers current 'look and feel' to a system that advocates a common 'look and feel' across devices from different companies. These companies may perceive a loss in the value they have added to their 'brand' of interface and may also perceive a threat from the potential loss of user loyalty normally found over markedly different brands.

3 Conclusions

While we accept that Sentinel is in its infancy we believe that our ideas are both sensible and deliverable. Because interfaces to ambient devices do not have the same complex requirements for visual layout - as maybe the case with desktop machines – the separation of interface and functionality into 2 separate devices is feasible and desirable. We feel that we have already made a good start with regard to the formulation of the device-interface requirements and development of the operability of our initial test bed. We intend to further prove our concept by delivering a working mobility interface for both sighted and visually impaired users. We shall also deliver a set of semantic descriptions (XML Schema / DTD and an Ontology) for data exchange and an abstract Java interface for both ambient device and user interface device. The Sentinel activity will eventually be tested in the real world along with the other components of the **proXimity** project and in collaboration with the Whitworth Art Gallery. We intend to demonstrate our system over 3-6 months with real users because the project is highly concerned with technical system testing, user evaluation and feedback. We have agreed to build a set of ambient devices and locate them within the gallery and build two egocentric user interfaces (mobile user devices using PDAs or 3G mobile phones). The Whitworth case study will be the final wild release of the Sentinel activity and the **proXimity** project (running through 2005) and is intended to test the system with real users in a real environment and performing useful tasks.

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