Challenges for End-User Development in CE devices

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ABSTRACT

To provide an answer to the potential challenges of technology trends with regard to user-system interaction, the vision of Ambient Intelligence is introduced. By positioning human needs in the center of technology developments, Ambient Intelligence requires interactive systems to be personalized, context-aware, adaptive and anticipatory. Two examples of such systems and their need for end-user development are discussed.

Keywords

Consumer Electronics (CE), Ambient Intelligence, Context-awareness, user experience

INTRODUCTION

From the area of technology development (see Figure 1) we learn that, amongst other performance indicators, the **storage** capacity and **connectivity** bandwidth increase rapidly. By having more storage and high bandwidth it becomes possible to deliver large amounts of Audio / Video content to CE devices.

This could bring forward the situation of content overload to consumers. In terms of storage capacity for example, we see the emergence of high capacity optical storage media (today up to 22 Giga Byte) small enough to be integrated in many devices including portable systems. Connectivity is being supported by many different standards going from short-range wireless (low power) to full in-home networks for streaming high quality multimedia content.

In order to cope with this potential content overload, more functionality (such as different query and content management methods) will be introduced. The danger of this approach is that consumers will spend more time on operating devices than actually enjoying the content they want.

By positioning the human needs in the center of technology development, **Ambient Intelligence** aims at providing an answer for these scenarios.

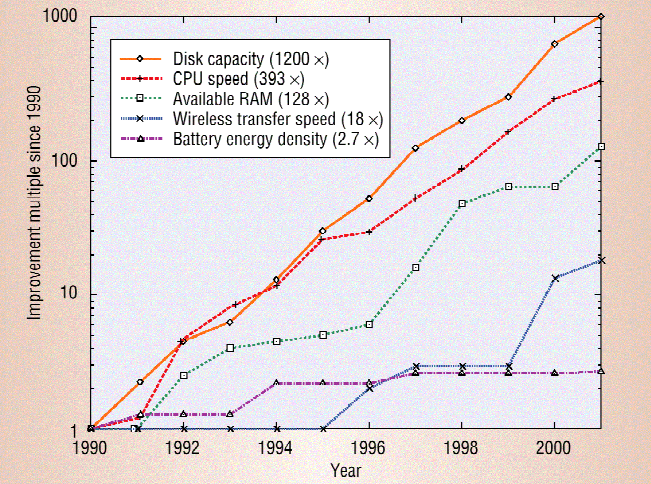

Figure 1: Moore's law for trends in storage, CPU, memory, wireless connectivity and battery technology

Ambient Intelligence is a vision of electronic environments that are sensitive and responsive to the presence of people [1]. Realizing user experiences and serving human needs (rather than pushing technology forward) are the main objective of this vision. These user experiences are not linked to one particular device but are realized by a network of intelligent devices present in the environment.

The different aspects of Ambient Intelligence are summarized in **Figure 2**.

Embedded	**Many invisible distributed devices in the environment**
Context aware	**that know about their situational state**
Personalized	**that can be tailored towards your needs**
Adaptive	**that can change in response to you and your environment,**
Anticipatory	**that anticipate your desires without conscious mediation**

Figure 2: aspects of Ambient Intelligence

Central in the realization of these aspects is that interactive systems should have some form of intelligence. However, given the fundamental need of users to be in control, end-user development becomes important to give users the ability to modify or program the behavior of their intelligent environment.

In the next section two scenarios requiring **end-user development** are discussed. While the first example describes a context-aware system that uses its situational state to change its behavior, the second example describes an interactive system by which users can personalize the experience of waking up.

The context aware remote control

One important property of intelligent systems is their awareness of the context in which they are being used. By adding some sensor and reasoning technology, a device can be made adaptive and exhibit adequate behavior for a given context [3].

As an example of a context-aware device, a universal remote control (based on the Philips PRONTO) with the ability to control different devices (such as TV, Audio set, etc.) is augmented with several context sensors that capture information with regard to the presence of people and devices in the environment. In addition to device control, the device is able to present an Electronic Program Guide (EPG) and give reminders for upcoming programs that match the preference profile of the user.

Figure 3: the concept of a context-aware remote control implemented on the PRONTO

By reasoning about the information obtained by these sensors, the device can (a) display an adaptive user interface to access the functionality relevant for the context of use[1] and (b) modify the way of reminding the user of upcoming programs that match the preference profile of this user[2].

The behavioral rules of the device that use the sensor information are not fixed in the software of the device but are represented by means of production rules that can be processed by an inference engine running on the context-aware remote control. To provide users with the ability to modify these behavioral rules, adequate programming tools need to be developed. Today, users of the **Philips PRONTO** can use the **ProntoEdit**[3] tool to modify the look-and-feel of

[1] Depending on the devices detected in the environment, the remote control can adapt the functionality offered through the user interface

[2] Depending on the usage context (noisy environment, multi-user situation, etc.) the remote control can adapt the mechanism of providing user feedback

[3] The **ProntoEdit** tool can be retrieved freely from the **Philips PRONTO** Internet site. End-users can publish their designs and share these with other Pronto users.

their universal remote control (see Figure 4). This tool allows end-users to design their own user interface for controlling CE devices with the **Philips PRONTO**. By selecting user interface elements (e.g. Button widgets) and associating these with Remote Control Infra Red codes, users can design complete interfaces.

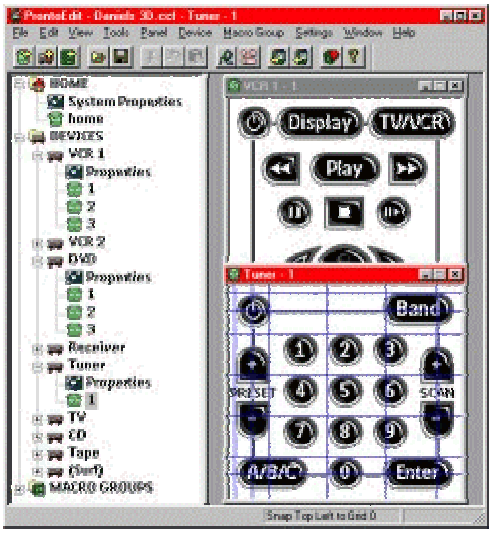

Figure 4: the end-user tool for programming the look-and-feel of the Philips PRONTO

To enable end users to modify the behavioral rules of context-aware devices, different programming metaphors need to be developed. This is one of the challenges for End User Development.

The wake-up experience

Survey studies into the characteristics of the home of the future have indicated the user need for customizing the wake-up experience, as many people are dissatisfied with their current wake up experience. By means of a questionnaire study with 120 respondents, [2] gathered user requirements for conceptualizing the optimal wake-up experience by asking respondents to describe their ideal wake-up experience. Although respondent differ greatly in the definition of their ideal wake-up experience, a common set of requirements was established. Examples of these include the requirement for a system to generate several stimuli simultaneously, the ease-of-use to create and modify a personal wake up experience and the ability to set the intensity of the different stimuli that compose a wake-up experience.

One of the major challenges is how to support people in designing their wake-up experiences. To avoid problems such as those known from VCR programming, the need for a simple but creative programming means was investigated via a workshop. Different concepts for creating a wake-up experience were collected and weighted (in terms of their feasibility and novelty). The selected concept is based on the analogy of making a painting.

Using a pen on a pressure-sensitive display, users can ‘paint’ their desired wake up experience. The display can be positioned on the bedside table where it can act as any normal alarm clock, just showing the time. However, when the pen approaches the display, the clock changes into a painting canvas. Here, users can select a certain time interval, for instance from 7.00 to 7.30 AM, for which they can start painting their desired wake up experience. A timeline for the interval is shown at the bottom of the canvas. People can choose a color from a palette of predefined wake-up stimuli, such as sounds of nature, lighting, coffee and music. The position of a stroke determines the time of ‘activation' of the stimulus, whereas the thickness of a stroke, controlled by the pressure on the pen, represents the intensity of the stimulus. At the moment of ‘painting' there is immediate feedback on the type and intensity of the stimulus that is set (except for the coffee maker for practical reasons). For instance, while making a green stroke, sounds from nature are played with the volume adjusted to the current stroke thickness.

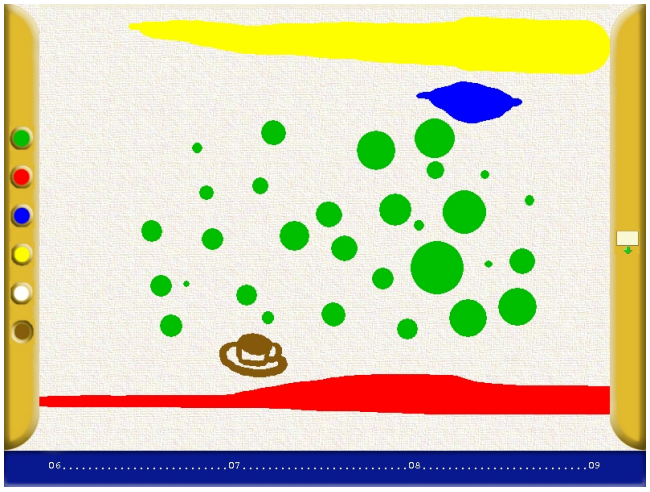

Figure 5: the interface for painting a wake-up experience

In the morning at the adjusted time interval the system generates the created 'wake up experience' by controlling the devices in the networked environment (such as lighting, coffeemaker, music, fan etc.). Figure 5 shows an example of a 'painted wake up experience'. In this example the system would start to raise the room temperature (red), then activate soft lights (yellow) and soft sounds of nature (green). These stimuli will gradually increase in intensity. The coffee maker will be switched on after some time (brown) and somewhat later music will be played for a few minutes (blue).

Conclusions

Technology trends can lead to future usage scenarios of consumer electronics that require users to interact more with system functionality than actually consuming Audio/Video content. The vision of Ambient Intelligence provides a framework in which embedded technology adapts to the needs of these users by being personalized, context-aware, adaptive and anticipatory to the needs of users. However, by adding intelligence to interactive systems, we emphasize the importance of end-user development given the need for end-users to be in control. Two applications of Consumer Electronics that require end-user development are presented. These applications emphasize the need for suitable models of end-user development in the area of consumer electronics.

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