# TOWARDS PLUGGABLE USER INTERFACES FOR PEOPLE WITH COGNITIVE DISABILITIES*

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Abstract: We present two user interfaces: one multimodal dialogue system and one task-based calendar which assist people with mild cognitive disabilities affecting their concentration and memory. A new middleware based upon a new open industrial standard—ISO/IEC 24752 Universal Remote Console (URC)—allows access to any network services or appliances as well as devices for home entertainment and household via abstract user interfaces. This architecture promotes the concept of pluggable user interfaces, that is, the abstract user interface being rendered on a controller.

## 1 INTRODUCTION

In a modern home environment, handling complex media devices, e. g., TV, radio or DVD player, but also household devices, e. g., washing machine, fridge, freezer or oven, is only possible through proprietary user interfaces which are typically remote controls or built-in control panels. In a considerably high number of cases, even mainstream users have problems executing seemingly moderate tasks, such as recording a movie. In most cases there is a lack of support offered by the in-house solution concerning meaningful and user-friendly user interface design. The task of designing intuitive user interfaces is getting even more important if the target group includes people with cognitive disabilities. A crucial point of why new technologies actually remained beyond their grasp depend on how much or how little attention has been paid to user interface design.

A possible solution to address this problem is to create one single user interface customized for the target group that spans all appliances at home in a homogeneous way. Such a user interface should be intuitive and not overtake users, e. g., with unnecessary features. The target users focussed on in this work need support for recurring tasks via home automation.

These requirements, among others, are addressed by the EU-funded project i2home (`www.i2home.org`), where the newly published ISO standard *Universal Remote Console* (URC) (Zimmermann and Vanderheiden, 2007) is used as a middleware (UCH) for interacting with a smart home. The UCH exposes an abstract description of the appliance or service (*target*) in form of a "contract" (*socket description*). All targets are thus exposed in a coherent way which enables a user interface designer to focus on the interaction concepts.

## 2 USER-CENTRED DESIGN

The i2home project incorporates technical and user partners from different European countries and aims at opening access technologies around home appliances for persons with special needs. In this, a major aspect is to design standardized access strategies that are also applicable to domains beyond scenarios linked to the home environment. One outcome of the project is the development of an accessible platform for abstract user interfaces that can be plugged (see

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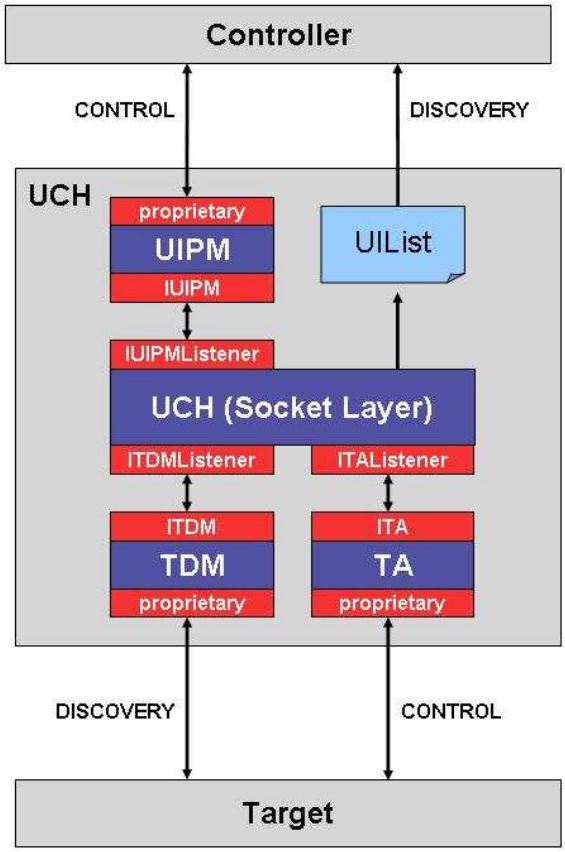


Figure 1: The Universal Control Hub architecture.

section 3) and rendered independently.

By pursuing a user-centered design (UCD) approach, e. g., ISO 13407, the interaction is completely based on real user needs meaning that different user types are the driving force for the development of technology. A key ingredient at this point is Cooper's persona approach (Cooper, 1999) describing different users in various stages of the development process. On the basis of this approach several general descriptions, personae and scenarios have been constructed bearing the typical characteristics of interviewed participants (Buiza et al., 2007). User interfaces implemented for these personae are evaluated and the results and experiences are fed into the requirements phase again. This cycle has been executed three times.

In this paper, we focus on 1) a multimodal dialogue system and 2) a task-based calender which have been designed jointly by the technical partner *German Research Center for Artificial Intelligence* (DFKI GmbH), and the user partner *the Swedish Institute of Assistive Technology* (SIAT). Our target users are represented by the persona Emma, 28 years old, who is living with her boyfriend, and, due to a car accident, is suffering from concentration and memory problems. Emma is the synthesis of approximately 20 persons. By using her UI, she can, in a coherent manner, interact with a number of targets. Among the most prominent ones we have consumer electronics1. e., DVB-T in combination with Windows Media Center, kitchen appliances and a calendar/reminder. The selection of targets is derived from scenarios implementing realistic daily activities in Emma's life.

# 3 ARCHITECTURE: THE UNIVERSAL REMOTE CONSOLE

The i2home architecture is built upon a new series of industry standards (ISO/IEC 24752 Universal Remote Console & ANSI/CEA 2018 Task Model Description) for interfacing networked appliances by means of a Universal Remote Console (URC) (Zimmermann and Vanderheiden, 2007) and for adding to the UIs, support for interaction, see (Rich, 2009). The implementation thereof is a middleware called universal remote console (UCH) that supports up-to-date prominent communication standards and allows for controlling multiple devices at the same time, see (Zimmermann and Vanderheiden, 2007). This allows for the implementation of scenarios like leaving home: as a person leaves his house and locks the door, some running appliances should be turned off—TV, hood, oven the heating should depending on the situation be lowered—and the alarm system should be activated. The UCH architecture is based on the concepts of a hub—**UCH**—which is a gateway-based architecture implementing the URC standard managing the communication between controllers and targets: a **Controller**, that is any device for rendering the abstract user interface, e. g., TV, touch screen or the smartphone presented in this paper; a **Target**, which is any networked device or service intended to be controlled or monitored, e. g., kitchen appliance, home entertainment or security devices; and, finally, a **Resource Server**, a global service for sharing user interfaces and other resources necessary for interacting with the targets.

The benefit of this approach is that we can deploy consistent and, particularly, accessible user interfaces which are tailored to particular users.

## PLUGGABLE USER INTERFACES

The URC framework provides an abstract definition the abstract user interface layer between the back-end devices and the front-end user interfaces (see figure 1). This *user interface socket* describes on an abstract level the input/output behavior of the appliance. The socket (or sockets) is (are) then rendered on some controller thus giving the abstract user interface a concrete implementation, or, in other words: plugging the socket (Vanderheiden and Zimmermann, 2005). Clearly, this architecture offers a flexible way of connecting different user interfaces with any user interface socket. Multiple controllers can be attached, exchanged and detached at runtime.

# 4 TWO CONCRETE USER INTERFACES

The configuration of the i2home system considered here contains a wide range of appliances and services: Google calendar; TV (Microsoft Windows Media Center); Siemens' `serve@Home` kitchen (hood, oven, fridge, freezer, dishwasher and air condition); SweetHeart blood pressure meter; and SmartLab Genie blood sugar meter. For these appliances, we show two UIs that have been implemented based on Emma, see section 2 and have been evaluated with real users.

**A Mobile Multimodal Dialogue System:** Figure 2 depicts a multimodal user interface for interaction with graphics, speech and pointing gestures. The interface is implemented by using the Ontology Dialogue Platform (ODP) (Schehl et al., 2008). Given a client-server architecture, the client part of the UI is running on an HTC 7500 Advantage running Windows Mobile 5.0 and the server on a standard PC.

**A Task Based Calendar:** A common challenge when creating intelligent user interfaces is the complexity of modern appliances. In (Rich, 2009), an approach for creating task-based user interfaces is described, where the main idea is that computer-controlled devices should actively help the users to operate the device and therefore reduce their own complexity. This approach has been adopted in i2home by integrating a task model engine with the UCH. Figure 3 shows the i2home calendar interface, which is, in contrast to a standard calendar application, completely based on the notion of task models.

In addition to traditional calendar features, the i2home task based calendar enables the users to schedule predefined tasks. Therefore, the users will not only be reminded of a task—the calendar automatically triggers tasks and thus assists the users by giving instructions or automating the necessary steps to perform arbitrary tasks which might or might not interact with the appliances connected to the system.

Figure 2: The i2home multimodal UI for smartphones showing interaction with a TV.

DFKI and SIAT have developed several task based scenarios for people with mild cognitive disabilities. Examples of tasks in this domain include preparing a meal, watching DVD or handling daily activities like morning routines, medication or blood sugar measurement.

# 5 CONCLUSION AND FUTURE WORK

We have presented two different pluggable user interfaces that provide consistent access to the digital home environment for people with cognitive disabilities. They are rendered on the basis of the new open industrial standard ISO/IEC 24752—the Universal Remote Console (URC). URC offers a flexible middleware platform that supports several communication standards and allows for interaction with any networked target device. The presented task-based calendar approach combines the notion of task models with commonly known calendar concepts and there-

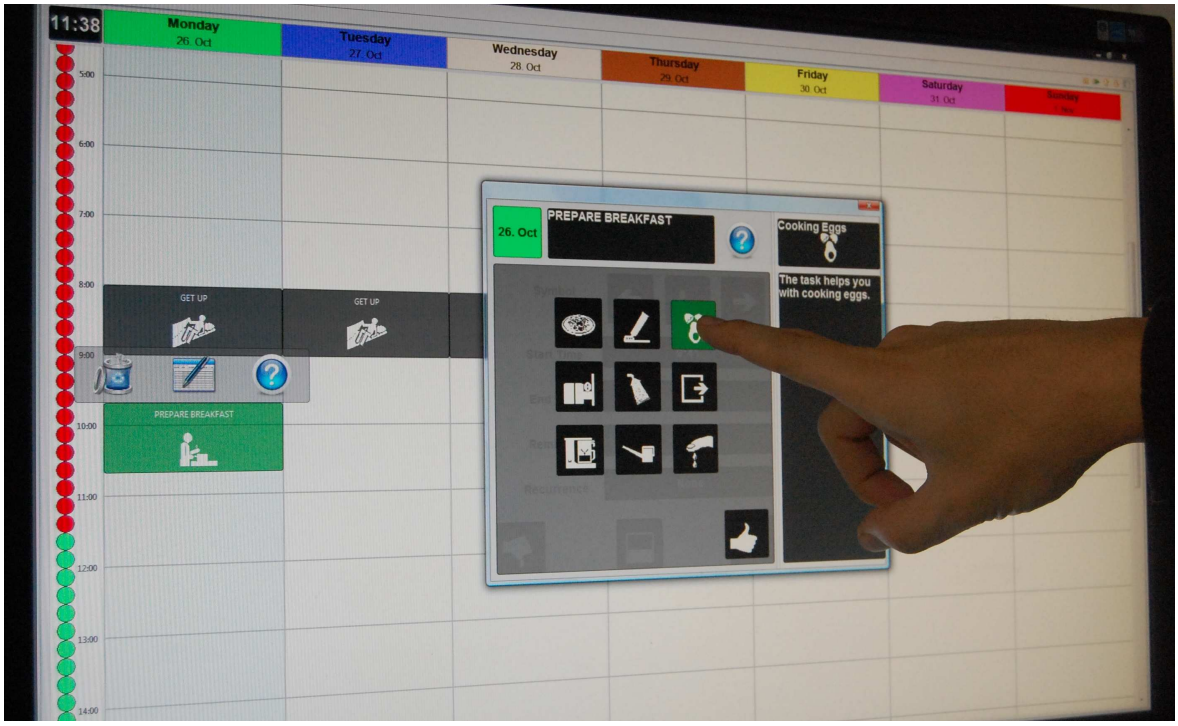


Figure 3: Picture of a test user interacting with i2home's task based calendar. The user interface follows special design guidelines for people with cognitive disabilities. For example, buttons and tasks are represented using a combination of text and pictograms[2], weekdays have fixed colors and the vertical timeline on the left displays the current time of day.

fore helps users with special needs to manage their daily activities. Based on the results of the third system evaluation, the next steps will include the resumption and optimization of the interaction concepts.

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