Universally Accessible Interactive Services on TV: A Case Study on the Provisioning of Internet Services to Elderly People

Universal-zugängliche interaktive Dienstleistungen auf dem Fernseher: Eine Fallstudie zur Bereitstellung von Internet-Dienstleistungen für ältere Menschen

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Kurzfassung

Der demografische Wandel stellt uns vor die Herausforderung, die Bedürfnisse älterer Menschen noch stärker als bisher ins Zentrum der Aufmerksamkeit zu rücken. Insbesondere die Teilnahme an der digitalen Revolution und der Zugang zu Internet-basierten Informationen und Dienstleistungen stehen dabei im Mittelpunkt. Ziel des VITAL-Projektes (http://www.ist-vital.org) ist eine erweiterbare Plattform auf Basis von vertrauten Schnittstellen in familiärer Umgebung (Fernseher, Mobiltelefon) zu schaffen, auf der eine Vielzahl leicht bedienbarer Anwendungen und Dienstleistungen verfügbar sind. Die Anwendungen selber werden ebenfalls im Rahmen des VITAL-Projektes entwickelt mit dem Ziel, sozialen Kontakt und Vernetzung zu Mitmenschen zu ermöglichen, sowie Unterhaltung, Weiterbildung und Information in altersgerechter Weise anzubieten.

Abstract

Through the demographic shift we face the challenge how to focus on the needs of elderly people more than is currently the case. In particular, the participation in the digital revolution and accessibility to internet-based information services represents key themes. The VITAL project (http://www.ist-vital.org) aims at creating an extendable platform on the basis of familiar user interfaces used in already known context (television, mobile phone) where a variety of applications and services are easily accessible to elderly people. The applications and services itself are also developed within the VITAL project, intended to enhance the social contact and networking among the users as well as offering entertainment, education and information in an age-appropriate manner.

1 Introduction

The myriad of services available on the Internet and their use on different devices (personal computer, DTV, mobile, mixed devices) is growing day by day. Governmental policy is promoting initiatives to build the future internet based on such services and is commonly known as the "Internet of Services". The goal of these initiatives is to enable users to combine and adapt these services easily to their specific context [1]. At the same time, watching TV is one of the activities that take up most of peoples' leisure time [2]. In this context, providing adapted Internet Services to the user on a familiar device that is most frequently used by them in their spare time is an interesting topic of research. For many users, the integration of these services into a TV set, means being able to access online banking, e-health services, having Web presence or socializing via available social networks, that otherwise would be inaccessible due to a lack of computer skills. This is especially true for the elderly.

In the iTV research community the integration of Internet Services with the TV has been an active research topic in recent years. Also, industrial development has been carried out to include such functionality in commercial products that have already been brought to market. However, in most of the cases, both research and industrial development has been targeted at mainstream users. Up to now, the research carried out on inclusive TV has mainly attempted to integrate specific services, or to make the TV remote control accessible to user groups with specific disabilities. The consequence is that the reuse of developed service adaptations has not been possible. An approach to integrate Internet Services with the TV easily, based on inclusive design and giving universal access to different user groups is missing.

We describe a new approach to integrate interactive services into the television and make them accessible by all. The proposal is based on the ISO/IEC 24752 "Universal Remote Console Framework" standard [3] which defines an abstract user interface layer and allows the development of pluggable user interfaces controlling arbitrary target applications/devices. An implementation of this approach focused on the elderly has being carried out, integrating services that aim to improve their quality of life. The instance of the abstract user interface layer has been developed for the typical elderly person, creating adapted graphical user interfaces and navigation menus together with multimodal interaction. An introduction of the URC technology and its fundamental concepts will be provided in the following section. We have evaluated the second prototype of the VITAL platform with a group of 30 users offering among other applications, an information service, chess, a quiz, video conferencing and audio books. Results from the user tests show that there is a high acceptance of applications running on TV that encapsulate Internet Services. In section 3 we will demonstrate this outcome by outlining the VITAL platform around two applications, the VITAL Information Service and the VITAL Personal Newspaper. Thus, we also give an insight into the ideas behind the backend services that deliver the actual contents to the applications. In the fourth section, we describe the integration of a Speech Interface – the VITAL Dialog System has been developed and plugged into the VITAL platform in order to access the target applications. This allows for end users to have an additional speech modality to control the applications. Finally, we give a short summary and an outlook on ongoing efforts.

2 Universal Remote Console

The Universal Remote Console (URC) framework [3], see figure 1, connects any networked device or service with any controller. The first project in Europe using URC technology was i2home (http://www.i2home.org/) which was an ambitious effort to inject an ecosystem around the industrial URC standard and to introduce URC technology in the field of AAL. Currently more than one hundred organizations and companies in Europe are using or working with i2home and/or URC technology. The URC standard provides an architecture called pluggable user interfaces that allows for interfacing arbitrary networked appliances or services with - in principle - any user interfaces. This allows for personalized and, perhaps most important in the context of AAL, accessible UIs. The architecture is based on the concept of a Universal Control Hub (UCH) [4] which is a gateway-based architecture implementing the URC standard and thus manages the communication between controllers and targets:

- A **Controller** is any device for rendering the abstract UI, e.g., TV, touch screen or Smartphone.
- A **Target** is any networked device or service intended to be controlled or monitored, e.g., kitchen appliance, home entertainment or eHealth devices.
- A **Resource Server** is a global service for sharing UIs and various resources necessary for interacting with the targets.

The benefit of this approach is that it is possible to deploy consistent and, more importantly, accessible interfaces which are tailored to the users and their specific needs. Currently, a pilot resource server is being operated by dot UI (http://www.dotui.com). The UCH architecture mainly consists of three layers:

- The *UI Protocol Layer* is responsible for communicating with controllers.
- The *UI Socket Layer* defines the standardized contract between controllers and targets.
- The *Target Adapter Layer* manages the grounding and communication with actual targets.

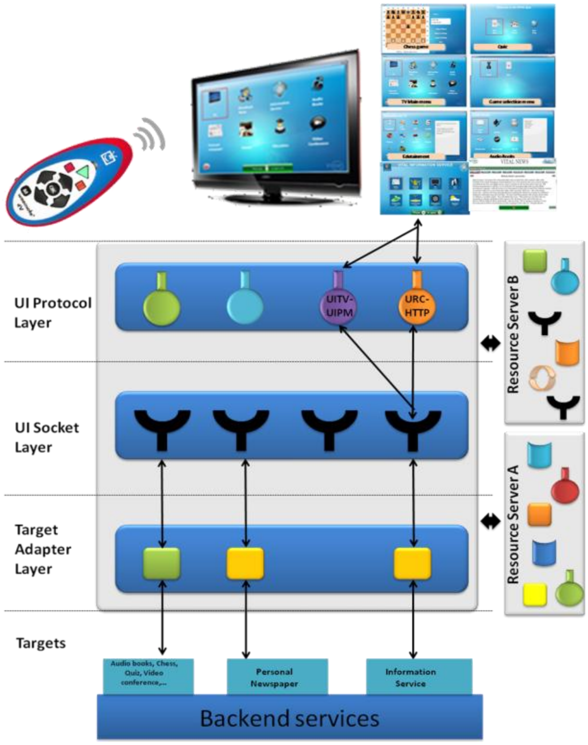

Figure 1 The layered URC framework allows for any target device to be accessed and manipulated by any controller device.

One of the key features of the URC framework is the standardized definition of the UI socket layer between the backend devices (targets) and the front-end UIs (controllers), see Figure 1. This user interface socket describes the input and output behavior of the appliance on an abstract level. The socket is then rendered on some controller, thus giving the abstract UI a concrete implementation or, in other words: plugging the socket [5, 6]. The concrete UI would connect to one or multiple sockets in two directions: first, getting the values that reflect the current state of the target, and second, requesting changes in the target's state through variable changes and function calls. On the backend side each target appliance is represented by a dedicated target adapter that is responsible for the grounding of abstract socket elements with any specific network protocol. Clearly, this architecture offers a flexible way of connecting different UIs with any user interface socket and therefore with any connected target application. Multiple controllers and targets can be attached, detached and exchanged at runtime. In the VITAL scenario the actual rendering happens on a so-called UiTV that is embedded into TV equipment. A Weemote (http://www.weemote.com/), see figure 1, acts as a controller. With only a few buttons it facilitates the overcoming of barriers elderlies would have with new devices. The UiTV client communicates via a protocol as specified in [7] with the according UIPM.

3 Personalized Internet Services

Elderly people are often reluctant to use new media because of technophobia. Since the VITAL system is intended to be used by this population segment, we decided to avoid the use of web browsers, direct access to search engines (instead, the information service invokes a query on behalf of the user), and even hide the fact that the user accesses the internet at all. The complexity of web pages with different frames, links, and advertisements is hidden and only the content related information is visible for the user. In order to accomplish transparency of the content for the elderly, we encapsulate the knowledge about the web site we use into the project's ontology. Instead of showing a web page, the concepts of the ontology are displayed. Using this approach "web-surfing" is substituted by browsing through an ontology tree [8], thus improving web usability for digitally disadvantaged persons. Some approaches exist where ontologies for user profiles are build up from scratch, for an example see [9]. In VITAL, the ontology tree is defined in advance – information about the 'real' interests of the users is obtained via a questionnaire which is filled out beforehand – but can be revised offline by an administrator. The personalization approach presented here is strictly content-based, i.e. recommendations for users are derived from topics for which the user has demonstrated interest before. For privacy reasons, collaborative filtering techniques [10] or combinations of content-based and collaborative approaches [11] were not taken into consideration.

3.1 Vital Information Service

The Vital Information Service is an intelligent personal assistant, with the mission to ease the access to information present in the web by designing a very simple browsing tool and providing the means to personalize the information topics. Here, the ontology defines the conceptual relations in the domain. Furthermore, it assigns web pages to concepts and specifies the rules to extract the documents. In a second step, the ontology also provides a description of the content of specific web pages. User preferences and interests of a specific user help to further restrict the space of concepts. Learning of users' interests is done by statistical evaluation of previous user behavior. Since the tree is more a general representation of topics of interest than a representation of a specific user's preferences, the ontology of concepts is complemented by weightings which represent user related preferences. The decisions of the user are traced and stored in an individual copy of the ontology tree. Combining a probability approach and a vector space model [8], a personal recommendation service provides interesting documents which are instances of the favored concepts in the ontology tree. Two instantiated concepts among other preselected topics that have been established by the users' preferences are:

- **TV**: A personalized guide to the daily TV programme. The user can browse through all programmes split into categories (e.g. movies, sports, series, music and more), displayed as the sixth category in figure 2.
- **Wellness**: Information about a healthy life style, suggestions for staying in good shape, news about advanced techniques in medicine and so on; see the last category in figure 2.

Figure 2 A screenshot of the start page of the Vital Information Service is displayed. Preselected topic areas are distinguished by big icons and ordered by users' preference that may change after usage.

3.2 Vital Personal Newspaper

The Vital Personal Newspaper application creates a daily virtual newspaper containing only information the system considers could be interesting for a specific user. The information is presented in a graphical layout similar to that found in a real newspaper. Based on the information about the users preferences stored in the user profile, VITAL uses intelligent agent technologies to search for the desired information in the web and data bases. The result is summarized, formatted, and presented inside the personal newspaper.

Figure 3 A screenshot of the Personal Newspaper, having the control focus on the first category "Sport".

One technical aspect in the context of evolving the URC technology is to explore different paradigms to integrate web services into the UCH ecosystem – a WSDL interface in the Information Service and an exemplary Restful service implementation in case of the Personal Newspaper – which has been novel up to now.

4 Vital Dialog System

The overall core component of the multimodal dialog system is represented by the Ontology-based Dialog Platform framework (ODP). It provides an open architecture for building multimodal, task-oriented user interfaces that is in concordance with large parts in W3C's multimodal architecture proposal. In particular, for the specification of the ontology we chose the OWL formalism recommended by W3C [12] and identify a subset that suits the underlying data representation, the Extended Typed Feature Structures (eTFS). The eTFS format unifies the properties of RDF/RDFS [13] and typed feature structures [14]. For the runtime knowledge processing we have an eTFS API that provides useful methods to compare two types and also fast access to related concepts within the inheritance hierarchy. The latter tool is especially essential for the reasoning engine of ODP – the Ontology-based Production Rule System (PATE) [15]. PATE's architecture is centered around the idea of three separated data storage facilities: (i) the goal stack, (ii) the working memory, and (iii) the long-term memory. The working memory is responsible for the activated instances so-called Working Memory Elements (WMEs), which are accessible for processing, i.e., rule applications. The long-term memory is responsible for the persistent storage for all instances of the type hierarchy the system has in the background. The purpose of the goal-stack is to represent the focus of attention within the process of the system [16]. The placing of WMEs between the three data storage parts is organized by the activation value which changes in the processing flow and the effects taken by rule applications. In every state of processing there is always one single WME in focus, which has an impact on the rules accessible for firing. Only rules whose goal-condition matches the pattern of the WME on top of the goal-stack have a chance to fire.

We conceive the Vital Dialog System (VDS) as a scalable and modular unit which provides voice control over the applications integrated in the Vital Platform. The challenge here was essentially to integrate the ODP framework into the UCH and the UiTV-UIPM. In order to achieve a consistent context between what is happening on the target side (e.g. personal newspaper target) and on the user interface side (UiTV) the internal state of the ODP needs to be synchronized with those two components. As we can see in figure 4, the ODP docks by means of the two different services; the UIPM (User Interface Protocol Manager) that speaks the URC-HTTP protocol, i.e., receiving and posting socket modifications to the targets and the UIPM that speaks the protocol interpreted by the UiTV:

- **The Function Modeler** supplies the ODP with the information returned by the target that are converted into TFS objects and serve the Information State Module update its own state.
- **The Presentation Planner** implements a service that invokes event handling on the UIPM. The UiTV client exclusively processes rendering information which is made ready by the UIPM. In case the context information is not fully covered by the information retrieved from the target, VDS uses the rendering information as complementary input.

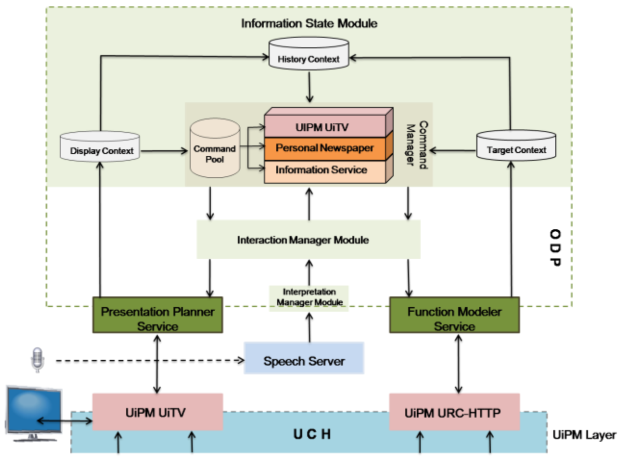

Figure 4 The VDS architecture demonstrates that its internal state is synchronized via two channels able to communicate the languages of the default protocol proposed in the standard and the UI protocol which is relevant to the UiTV-UIPM.

Furthermore, within VDS different tasks are partitioned into multiple modules:

- **The Interpretation Manager** carries out natural language interpretation. For that purpose it processes the word lattice reflecting the user's vocal utterance with its semantic interpretation of the utterance. The natural language understanding component of Vital interprets the recognized spoken input of the user and converts it into instances of the ontology.

- **The Interaction Manager** has the task to resolve commands that invoke the service of the Presentation Planner or the Function Modeler. Typically when the user utters commands specific to the UiTV, i.e., "Go to the Main Menu", an ontological concept *SwitchApplication* is created and the interaction manager invokes the presentation planner to send that information to the UIPM.
- **The Information State** synchronizes the ontology-based representation of the target grounded on the variables that are updated after each manipulation on the target's side. Additionally, the Information State processes the updates received by the UIPM for the UiTV and maintains a knowledge base referring to the displayed content on the UiTV. This is crucial when we change the input modality and allow the user to mix voice interaction together with the control of the Vital Platform via the Weemote.

Possible utterances by the user are described by a grammar, maintained in a W3C standard compliant format. However not only predefined speech input is accepted; the framework allows for loading new grammar entities on the fly. This is useful in the context of dynamic concept names (e.g. the title of a movie), which are created using information available from the web at runtime.

5 Conclusion and Outlook

In this short paper we have introduced a methodology of how to make modern technology – in this case Internet Services – accessible to elderlies. Our featured technology, the URC proves to be an adequate vehicle to even integrate web services in the world of heterogeneous controllers and user interfaces. Different web service approaches have been integrated successfully to the existing infrastructure by using the specific components proposed in the standard. A speech interface has been presented that acts as an additional modality to the Weemote remote control. The dialog system implementation has been arranged within the given overall architecture.

In the next step we want to anchor the idea of integrating web services into the URC Standard. Currently there are countable activities related to the objective to assimilate the WSDL description into the socket description of the URC. Furthermore, we want to push initiatives focusing the ubiquity of services. The goal here is to have a Personalized User Interface where settings and contents can be installed from one or more Resource Servers onto the end users' controller, no matter in which UCH environment the user is located.

6 References

[1] European Commission CORDIS. ICT Program: SSAI. http://cordis.europa.eu/fp7/ict/ssai/home_en.html

[2] Zillmann, D. and Vorderer, P; Media Entertainment: The Psychology of Its Appeal (Lea's Communication Series). Lawrence Erlbaum Associates, 2000.

[3] ISO. ISO/IEC 24752: Information Technology – User Interfaces – Universal remote console – 5 parts. "International Organization for Standardization", 2008.

[4] Zimmermann, G. and Vanderheiden, G.; The universal control hub: An open platform for remote user interfaces in the digital home. In Jacko, J. A., editor, *Human-Computer Interaction*, volume 4551 of *LNCS*, pages 1040–1049. Springer, 2007.

[5] J. Frey, C. Schulz, R. Nesselrath, V. Stein, and J. Alexandersson. Towards Pluggable User Interfaces for People with Cognitive Disabilities. In Proceedings of the 3rd International Conference on Health Informatics (HEALTHINF), January 2010.

[6] G. Vanderheiden and G. Zimmermann. Use of user interface sockets to create naturally evolving intelligent environments. In Proceedings of the 11th International Conference on Human-Computer Interaction (HCI 2005), Las Vegas, Nevada USA., 2005.

[7] Slováček V. – UIProtocol specification draft 5. Draft of specification, Czech Technical University, Prague, 2008.

[8] Zinnikus, I., Fraser, C. & Fischer, K. (2004). An Ontology-Based Recommendation System. In Proceedings of *Artificial Intelligence and Applications* (AIA 2004), Innsbruck, Austria, 2004.

[9] Godoy, D., Amandi, A. (2001). Building Subject Hierarchies for User Modeling. *2nd Workshop on Advances & Trends in AI for Problem Solving*, Punta Arenas, Chile, November 2001.

[10] Konstan, J.A., Miller, B.N., Maltz, D., Herlocker, J.L., Gordon, L.R. and Riedl, J. (1997). GroupLens: Applying Collaborative Filtering to Usenet. *Communications of ACM*, Volume: 40, No. 3, pp. 77-87. March 1997.

[11] Liebermann, H. Letizia: An agent that assists web browsing. In *Proceedings of the International Joint Conference on Artificial Intelligence*, Montreal, pp. 924-929. 1995.

[12] McGuinness, D. L. and van Harmelen, F. OWL Web Ontology Language Overview. Technical report, W3C. http://www.w3.org/TR/owl-features/. 2004.

[13] Manola, F. and Miller, E. RDF Primer. Technical Report, W3C. http://www.w3c.org/Submission/OWL-S/. 2004.

[14] Carpenter B. The Logic of Typed Feature Structures. Cambridge University Press, Cambridge, England, 1992.

[15] Pfleger, N. and Schehl, J. Development of Advanced Dialog Systems with PATE. In Proceedings of the International Conference on Spoken Language Processing (Interspeech 2006/ICSLP), pages 1778–1781, Pittsburgh, PA. 2006.

[16] Anderson, J. R. and Lebiere, C. The Atomic Components of Thought. Erlbaum, Mahwah, NJ. 1998.