Fostering social interaction of home-bound elderly people: The EasyReach system

Fostering Social Interaction of Home-Bound Elderly People: The *EasyReach* System*

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Abstract. This paper presents the ***EasyReach*** system, a tool that aims at getting the elderly and pre-digital divide population closer to new technologies by creating a simplified social enviroment that facilitates interaction, trying to allow them to (i) easily keep in contact with friends and relatives, (ii) share their lifetime expertise, and (iii) avoid isolation. The ***EasyReach*** tool creates for the elderly a special social TV channel accessed by means of their own TV set and a specialized remote control endowed with gesture recognition, video and audio capture capabilities. A hidden personal assistant reasons on user preferences in the background allowing better focalization on his/her social interests.

1 Introduction

In contrast with a widespread belief, older people (although primarily benefit-driven) do use computers and Internet [1] and there is also evidence that the use of computers indeed improves the performance in daily living activities, increases cognitive functioning, and decreases the level of depression [2]. Nevertheless, several barriers like access, performance and psychological issues still exist, at least for some individuals.

The ***EasyReach*** Project[1] aims at providing an innovative and sustainable ICT solution to allow elderly and less educated people (i.e., pre digital-divide population) to participate in the benefits of ICT-based social interactions when confined at home for several reasons. The ***EasyReach*** system is specifically targeted

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towards those individuals who, because of poor scholarization, low income and linguistic barriers, still find it difficult to use computers to improve their socialization. The key motivation for the project stems from the known evidence that elderly people tend to isolate themselves, especially as physical deterioration constrains them to stay at home for medium/long periods. The solution pursued in ***EasyReach*** (see the sketchy impression in Fig. 1) consists in facilitating social connections among the elderly, and entails the cooperation of some state-of-the-art technologies to provide a non-intrusive solution with user-friendly and personalized access to services similar to those of social networks but designed to be close to the needs of an old person that is at home due to a physical impediment.

A key choice has been the use of the home TV to minimize the change of habits. The ***EasyReach*** systems comes with a set-top-box that introduces a "social channel" that makes available services to share the user experience with people outside (either single individuals or groups), while maintaining the access to all the usual TV channels. Great effort in the project is dedicated to the synthesis of a remote controller able to gather inertial and multimedia data to capture the behavior of the user. Such captured data are used for gesture-based interaction as well as for the creation of multi-media content from the user environment to be shared with the external world. The ***EasyReach*** Social Interaction Environment is the front-end of the social channel, and represents an interaction facilitator from the user to the external network (and vice versa). The social channel thus created provides some of the services usually attributed to state-of-the-art social media; yet these services have been here redesigned, extremely simplified and tailored to meet the needs of pre digital-divide population. A further aspect in the project is the use of a Personal Assistant (PA) to monitor both user activities and interests in the background, providing the user with proactive aid in the use of the ***EasyReach*** environment.

Fig. 1. Using EasyReach at home

This paper describes the project goals and the mid-term prototype that has been demonstrated live at the Ambient Assisted Living (AAL) Forum in Eindhoven in September 2012, receiving the attention of diversified stakeholder representatives. The paper presents first the architecture of the system (Section 2), then proceeds to describing its three main building blocks: the Hardware (remote control and set-top-box) will be presented in Section 3, the Social Interaction Environment will be presented in Section 4, while the Personal Assistant will be presented in Section 5. Finally, Section 6 describes the current evaluation steps according to a user driven methodology, while some conclusions end the paper.

2 The EasyReach Architecture

The ***EasyReach*** architecture is presented in Figure 2. We identify the main hardware elements: a TV set constituting the main user interface; the ***EasyReach*** Remote Controller integrating (i) a pointing service endowed with an inertial controller, (ii) a Hi-Res camera, and (iii) an audio recorder; a set-top-box (STB) providing the "gluing factor" among all hardware components thus allowing the user to access the system functionalities and join the ***EasyReach*** Network; an ***EasyReach*** Cloud representing the core of the ***EasyReach*** Network, responsible to convey the system services and to manage all user information stored into a centralized database (DB). The set-top-box runs the remote controller server (see next section) and the so-called "EasyReach Client" that contains the software for (i) the social interaction environment, (ii) the personal assistant and (iii) the services required for a flexible connection to the system centralized database.

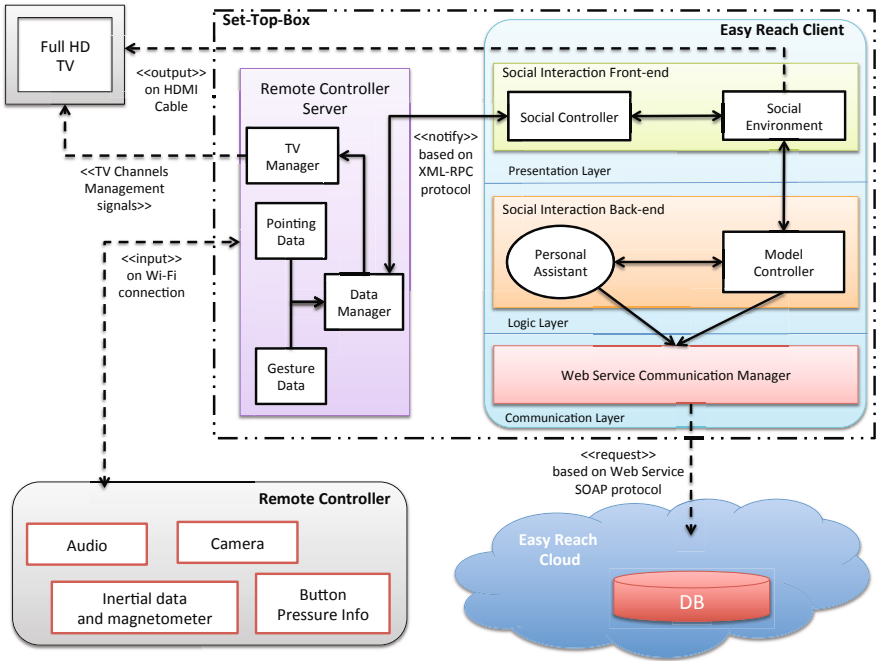

Fig. 2. The ***EasyReach*** architecture

3 Hardware Components and the Remote Control

A key design choice has been to provide a platform that features the TV-set as the media to access contents as well as to communicate over the Internet, making the inclusion of a remote control and a set-top-box the most natural choice to complete the hardware architecture of the system. The Figure 3 shows the ***EasyReach*** remote control, its enclosure and its internal electronics.

The remote control includes a complete three-dimensional inertial unit (with accelerometers, gyroscopes and magnetometers), a camera, a microphone, a keyboard and a rechargeable battery. The main characteristic of the remote control is that it gathers inertial and multimedia data to capture the behavior of the user.

In particular, the inertial data is used to track user movements as well as recognize particular gestures performed by the user for interacting with the system. A software component, running in the set-top-box, converts the low-level inertial data to pointer and gesture data in order to recognize higher level features such as particular movements (e.g., moving the remote left, right, up and down) and rotations (e.g., clockwise and counterclockwise). Figure 2 shows how both the HW and SW components of the remote control are integrated in the overall ***EasyReach*** architecture.

The camera and the microphone are used for gathering multimedia data. In order to interact with other users and share contents, the remote can be used by the user either for taking photos or for recording audio and video messages.

Moreover, the remote includes a simplified keyboard that can be used for performing simple actions such as turning the system on/off and for controlling the basic TV functions, as described later.

Fig. 3. The Figure shows the ***EasyReach*** remote control, its keyboard and enclosure and its internal electronics

Several prototypes of the remote control have been realized, starting with a software version based on a smartphone. Moreover, we developed several hardware devices working on cost reduction and energy optimization during time. The current device is low-cost and energy efficient; preliminary tests show that its battery can last for a few days of continuous usage. Given the first feedback of the final users, we are further developing the remote control from the ergonomic and easiness of use point of view.

The second main component of the hardware architecture is a set-top-box that is used for enabling and simplifying the user's interaction with a TV-set and the Internet. It is mainly used for (i) computing the data gathered by the remote control in order capture the user input and gestures, (ii) processing the multimedia information, (iii) directly controlling the TV-set, (iv) running the core social components and (v) managing Internet connections and contents.

Therefore, it has storage, processing power and main memory capabilities in the ballpark of an average personal computer. In order to provide the main Social Interaction front-end, the set-top-box is directly connected with the user's TV-set (normally through a HDMI cable). Moreover, it provides Wi-Fi connectivity and it has a programmable infrared device used for controlling the TV-set basic functions (e.g., channel switching and volume management).

4 The Social Interaction Environment

The ***EasyReach*** Social Interaction Environment aims at providing the elderly and pre-digital divide people with a simple and clean environment to interact with, where the information is easy-to-find and presented in a structured way. The interfaces of today's digital devices are often too complicated and dispersive for non accustomed people (e.g., the social applications on the smartphones, designed for small displays, and with a lot of "crowded" icons, or even the ordinary web pages, often very distracting due to their unstructured nature and the huge quantity of information displayed). A sketchy view of the ***EasyReach*** front-end is shown in Figure 4, while its SW integration within the overall system architecture is shown in Figure 2, as part of the ***EasyReach*** *Client* component.

Fig. 4. The Social Environment

Two main sections can be identified on the screen:

1. *The "Frame":* the static part of the environment, composed of the gesture-driven scrollable *contact bar* (at the bottom), containing the user's friends and relatives, as well as the people suggested by the Personal Assistant (see Section 5), the gesture-driven scrollable *group bar* (on the left), where the user can find his personal groups and the suggested ones, and a static *command bar* (on the right), displaying the list of the actions available to the user (e.g., take a picture/video, create a group and so on).
2. *The Information Area:* a dynamic part that changes on the base of the user's actions or selections: for instance, if the user selects a friend (as shown in the figure), or a group, the *Information Area* will show the messages exchanged between the user and the selected element; similarly, if the user visits his gallery or wants to create a group, the *Information Area* will switch according to the the user's selected action.

Social Functionalities. The main goal of the project is to build a system able to offer functionalities that prevent users from isolating themselves from the society. More specifically, the system intends to offer the possibilities to easily:

1. Keep in touch with friends and relatives in a more "immersive" way than can be achieved with a phone call or a letter.
2. Foster socialization with other people that have common interests with the user, in order to keep them socially active (e.g., sharing their experience and knowledge of a lifetime and giving/receiving help in any area of interest).
3. Create discussion groups or join existing ones.
4. "Reach" organizations even from home (both "communitary" ones, like user's church or senior center, and "official institutions").

The key idea of the Project is to be as simple as possible for the user, in both system installation and utilization. In fact, after connecting the STB to the TV, the user is immediately able to join the *Social Channel* and to enjoy the benefits of today's technology, even as a pre-digital divide user. With the ***EasyReach*** special remote control the user can take pictures and videos of a special event (e.g., a family dinner, a birthday etc.), share his/her knowledge and experience by creating a video-tutorial and posting it on thematic groups or, simply, have conversations with friends and relatives.

The remote control's gesture recognition mechanism helps the user to navigate the system, by giving him the possibility to scroll his list of users and groups through some simple gestures, like moving the controller right/left or up/down. After selecting one of the groups (or a friend) of interest, the user can immediately start exchanging messages and/or updates within the chosen context. Also, the system allows organizations and official institutions to join the *Social Channel*, in order to be easily reachable by the users, send them useful information/advises, and help them more directly. The opportunity to make the user's own expertise available to the whole ***EasyReach*** community can be invaluable to maintain the self-perception of being socially active. Also, the user himself can easily create new discussion groups or join one of the groups suggested by the Personal Assistant on the basis of the user's interests.

5 The Personal Assistant

The Personal Assistant (PA) is the software component that suggests new interactions through the social network, and is integrated as part of the Logic Layer in the Social Interaction Back-end component (see Figure 2). The PA not only analyses the profile of a user, but also monitors his activities and interactions within the social network, reasoning on these data to suggest new interactions. Basically, the PA suggests which items should be shown in the user's lists, where an item can be a person or a group; the suggestion may lead to a new interaction depending on the user's will to engage in an interaction regarding the selected person/group. A person who is not a friend of the user might be shown in the contact list because they have common interests. Similar reasoning can also apply to a group the user is not a member of. The user can check the suggested items and can send the person a message or check the group message board.

This implicit suggestion method is less confusing and annoying for the elderly than asking explicitly each time and making him feel forced to interact.

Next we explain how the PA works by intelligently selecting items to be shown in the user's lists. The PA module communicates with 2 modules through their respective interfaces: the presentation layer and the social engine database (see the architectural diagram in Figure 2). Note that the interface for the social engine database features a one way communication (i.e., the PA fetches data from the social engine to monitor interactions of the user), while the interface between the PA and the presentation layer manages two way communication. For instance, the presentation layer can invoke the PA when it needs to show the user's list items, and the selected items are returned to the representation layer. Additionally, the interface is designed so that the PA can get updates related to activities and interactions of the user within the social network; in this way some of inefficient polling of the social engine database are avoided.

We implemented a framework for the PA to suggest new interactions. Answer Set Programming (ASP; [3]), a popular declarative problem solving approach in the field of knowledge representation and reasoning, is utilized to implement the reasoning capabilities needed by the PA to intelligently select items to be shown in the user's lists (a similar approach to using ASP to implement suggesting interactions related to events in the social network is [4]). In this work we use the answer set solver from the Potassco answer set collection [5]. We refer the reader to [6] for the syntax and semantics of the ASP language.

In order to reason on user interests or group topics we need a model of interests; we utilize a taxonomy of users' interests for this purpose. The selection of interests is based on preliminary investigations about elderly needs, hobbies and expectations. Formally, we modeled our taxonomy as a forest of keywords of interests where the edges represent the subsumption relation among keywords. In the ASP program of the PA, the taxonomy is encoded by logic program facts for keyword nodes and subsumption relation. Figure 5 depicts a subset of the taxonomy used in ***EasyReach***. Note that the keyword *Documentary* is subsumed by *Programs*, and *Programs* is subsumed by *TV*. Thus, a keyword at a deeper level of a tree in the taxonomy represents more specialized interest than one at a shallower level. A user creates a profile by specifying keywords corresponding to his interests. The taxonomy allows the PA to exploit the semantic information inherent in a user profile. For example, when a user specifies Formula 1 as his interest, PA can use not only *Formula 1* but also *Auto racing* or *Motorcycle racing* for reasoning to suggest new items in his list. The following explains how PA performs this reasoning.

When PA is asked for populating new items for the user's lists by the presentation layer, it first considers the interests mentioned in the user's profile. Later, starting from interest nodes in the taxonomy, it traverses to connecting nodes using the subsumption relation. A connecting node must be reachable with a path whose length is expressed as a parametric value denoting the maximum allowed path length. For instance, let $\{Motorcycle\ racing, Formula\ 1\}$ be the set of interests mentioned in a user's profile and the taxonomy used be the one shown in Figure 5. Assuming that the maximum allowed path length is 2, the interest nodes

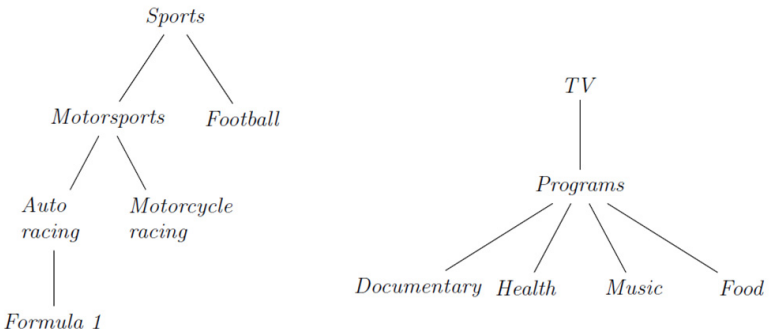

Fig. 5. A subset of the taxonomy of user's interests

reachable from *Motorcycle racing* are {*Motorsports*, *Auto racing*, *Sports*}. Considering all the interests in the user's profile, the PA takes the set {*Motorcycle racing*, *Formula 1*, *Motorsports*, *Auto racing*, *Sports*} into account when checking other users with common interests. Additionally, the PA assigns weight to the interests according to the depth of its node in the taxonomy tree. For our example the weight of *Formula 1* is greater then *Motorsports*. The intuition is that the more specialized a common interest is, the better the suggestion. We encoded the taxonomy traversal and weighting in ASP and formally modeled the item suggestion problem as a quantitative optimization problem where the reasoner tries to maximize the total weight of a selected set of items. The selected items are fed back to the presentation layer to be shown in the user's lists. Besides user interests, we plan to integrate other sources of information for suggestion new items; the quantitative optimization-based suggestion framework of the PA can handle such additional information. The location of the user or his recent activities within the social network, such as sending a message to a person from a common group, are also important information to be used in suggesting items.

6 Evaluation Steps

The ***EasyReach*** project adopts the User Centred Design (UCD) approach since its beginning. User involvement has been very intense from the early stages of the development process of the ICT services [7]. Primary users (elderly people) and secondary users (e.g., caregivers and relatives) have been involved from the early stages of the development process of the technical solutions. The main objectives of user involvement are: (a) to gather user needs and preferences for user requirements identification, (b) to test and evaluate the intermediate and final ***EasyReach*** prototypes. The UCD approach in the project is applied through three main steps:

1. A preliminary investigation about elderly needs, expectations and preferences with respect to ***EasyReach*** solutions was realized using the group interview technique. Firstly, contacts were established with user organizations: Federazione Nazionale Pensionati (FNP), a retired and elderly union,

in Rome (Italy) and the Ancescao association, a no-profit association promoting the social inclusion of elderly people, in Milan. A first group interview was realized (October 2011) in Rome using an appropriate methodology [8]. Further, two group interviews were carried out (February 2012) in two different Senior Centres in Milan.

2. A "second wave" of user involvement was realized to obtain feedback from end-users about the early design versions (using low fidelity prototypes) of some system components. A qualitative investigation using the group interview technique and involving a small number of potential users was realized in Rome (June 2012). User reactions were collected and the idea behind the project was judged good by participants to meet the need of the elderly "to remain in contact with the real world". Some requirements/critical points emerged, including: ease of use; adequate communication protocols; assistance to join groups with similar interests; protection from illegal behaviors; moderation in groups capable of settling a controversy when something unpleasant happens.
3. Three pilot studies are planned in order to assess the developed technological solutions in real life environments. The relevant characteristic of these pilots is to conduct field trials involving real users. The planned pilots are realized in different national, geographic and cultural contexts.

The main objectives of the pilots are: to evaluate system usability by the elderly people in different environments (e.g., home, senior center); to evaluate user experience [9] and user acceptance [10] of the ICT solution developed in the project; to evaluate the effectiveness of the ***EasyReach*** solution in terms of social inclusion and improvement of quality of life. Both subjective and objective techniques for data collection are employed. They include: semi structured questionnaires for elderly people, observation of interaction sessions, log file analysis, interviews with secondary users. Adequate procedures are adopted during pilots for training elderly. These procedures have the objective of getting the elderly person to think to be able to master the system reducing the sense of fear and inadequacy [11]. During pilots a reference person (tutor) has the task to provide any kind of help about the system use, to solve practical problems in the field trial and to motivate the elderly in correctly participating to the pilot. The three pilots are realized in two European countries: Italy (Pilot 1 in Rome and Pilot 2 in Milan) and Germany. The pilot in Rome involves two Senior Centres; they are selected to be representative of two different kinds of cultural areas. This pilot is realized placing the ***EasyReach*** prototype in two different environments: the home of the elderly people and the Senior Centre. The second Italian pilot is organized in the Castanese, an area in the northern part of Milan. Even in this pilot the ***EasyReach*** system is placed at the home of elderly people and at the senior centre. The German pilot is realised in the Florencenhort Seniorenzentrum at Stansdorf, a senior residence; it involves people living in this senior residence.

7 Conclusions

This paper presents a comprehensive description of a system that aims at counteracting the elderly's tendency to isolate themselves when they are constrained

at home for any reason. The ***EasyReach*** system proposes a new TV social channel aimed at creating a simplified interaction space between an old home-bound user and his/her network of connections spread over the internet. Special attention has been given to the particular communication bandwidth offered by the ***EasyReach*** remote control: the use of gestures, the photo, audio, video media, the very restrictive use of text. Goal of the system is to close the gap with people not familiar with state-of-the-art ICT technology and offer them an opportunity of using it. The following slogan might summarize what the project is trying to achieve: "using a pre digital-divide appliance to give access to post digital-divide opportunities". Our intensive tests with users in the final part of the project will assess the extent to which this goal has been achieved. Continuous intermediate tests have constantly encouraged us in pursuing the project objectives.

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