Disappearing Computing for Elderly Assisted Living

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***Abstract*—In this paper, an application for smart devices targeting elders who need to stay at home almost for the whole day, and require assistance (either social or medical) is presented. The proposed application utilizes a TV set-top box that communicates via a low-cost board. The aim of the work is to design a system based on COTS products, to offer modified home appliances with which elder people are familiar and hide the HCI from them, consequently allowing elders to use typical Internet Technologies.**

Medical Informatics Applications for Mobile Devices; Single-board computers; Low-cost systems in Medicine

I. INTRODUCTION

Nowadays technology is offering numerous applications to the people, aiming to facilitate their day to day life. However, elder people remain technology-fearful believing that Human-Computer Interaction (HCI) is complex and that they lack both knowledge and the required dexterities. However, most of the elder people would be benefited from the use of typical Internet Technologies, like video conference, news reading, or message exchange with family members, friends, social services, doctors etc.

This work describes the design of a system built of Commercial off-the-shelf (COTS) products that have been disguised as retro devices, which are familiar in use to every old person. The main display is their TV and a smart phone that looks like an ordinary phone, which is used as the input. A set of services, for the proposed system, has been developed, allowing quick dial of known phone numbers (telephone), video conference with the doctor or family members, RSS feed reading, and e-radio listening. Finally, since the architecture is kept open, a novel application for transmitting bio-signals to their doctor is also developed, enabling real-time health monitoring at low-cost.

II. EASE OF USE

Living in a country which currently faces economic crisis, many issues need to be addressed in the field of health. A significant issue is the difficulty of any patient to hire a professional to assist him/her, mainly due to financial reasons. Especially for people with disabilities and elders, needing caregivers for almost the whole day, the absence of health care professionals due to economic depression resulted also in the increase of personal depression due to the awareness of their loneliness.

Although there are excellent innovative products and services, research teams proposing smart solutions for detecting falls or generally accidents [1], for porting telemedicine to rural regions, for teleconferencing with familiar persons, or for assisting several diseases' patients (e.g. Symbiosis [2]), face lack of ease of interactivity directly with the elderly persons.

The aim of this work is to design a system based on COTS products, which are familiar to elder people and hide the HCI from them. Thus, elder people will try to interact with the system, without feeling the fear technology causes to them. Besides interactivity, the system should provide to elders features (software) that are available to nowadays home computers at an easy-to-use way. Finally, cost should be kept low in order for the product to be attractive to the elders.

An elder will interact with the system selecting from a list with few options (no more than 5). Options like weather forecast, videoconference and medical monitoring were selected for the testing of the system. However, our aim is to design an open system, allowing parameterization and population of the list from a wider plugin store, including radio streaming, news reading, simple e-mail reading and sending etc.

At this point it has to be stated that for the time being, the concept is based on developing a system, around a mini computer system offering the least necessary features and keeping cost low. The system includes in its heart a simple application appropriate for elders (concerning displayed colors, icons etc.), that triggers open source installed software, excluding processes like double-click, signing in, selection with mouse etc. which seem to prevent elders from using computers.

III. SYSTEM DESCRIPTION

A survey to identify devices that the elders tend to use more frequently and more easily was held. A small survey was carried at a small group of 6 persons aged 70+, with known technology fear and unwillingness to get trained to attain the appropriate dexterity. For avoidance of biased research results, 4 were males and 2 females, located in two different cities (Lamia and Patras, both in Greece), with different diseases (e.g. 1 with Parkinson disease etc.) The first device that was identified as the most frequently used was the TV set, which becomes ideally the display of the system. Every option is displayed on the TV, as a separate channel. The second one was the phone device, which is ideal as an input peripheral of

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the system. The third one was the radio, which hasn't been exploited yet.

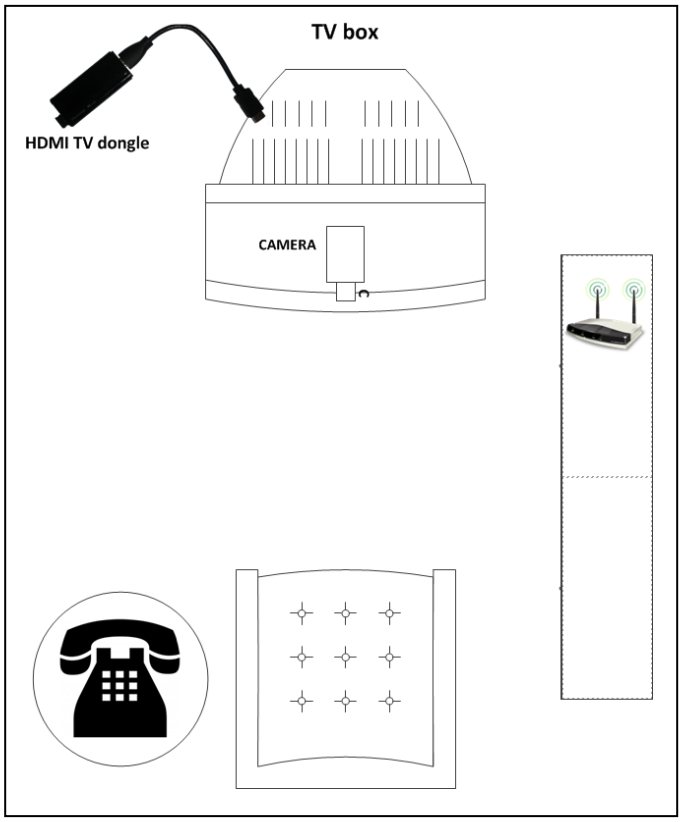

Figure 1. System's topology

In order to transform the TV to a smart TV, an Android-installed HDMI dongle was selected to be used, since cost is low and the airmouse that accompanies a typical HDMI dongle is similar to the TV remote control. The more sophisticated task was to transform the phone device to an input device, or a smart device to look like a retro phone. Finally, the second approach was selected, due to the available equipment in our laboratory. A grey phone handset was used with a mini USB input, found in every e-shop providing electronic equipment and a cheap tablet as the keypad. Now, a classic black retro phone is developed using an Arduino board for transforming angular position and button pressing (depending on the type of phone) to electronic signals to the HDMI dongle. Finally, a web camera was also added to the required equipment for teleconference, as well as several adapters (mainly for old TV sets).

The communication of the devices is achieved wirelessly using either Bluetooth or Wi-Fi. Bluetooth was selected to be used in the communication of the airmouse with the HDMI dongle Thus a wireless router is required to be installed in the elders house, providing also the Internet connection. In Fig. 1 the block diagram of the system is provided.

IV. System Development

The system was developed as a web service in order to achieve high compatibility with various HDMI TV dongles available in the market, and address issues concerning updates and scalability issues. Proof of concept was achieved with rapid prototyping using Intel XDK [3] framework. This framework was selected, because the projects are easily manipulated targeting either web or smart devices installation, giving us the ability to port the project to the device in the future as a native application.

The Intel XDK is an HTML5 development studio, allowing rapid prototyping and porting of the project to many different targeted platforms. It gives the developer also the opportunity to easily add features found on smart devices, from peripherals like camera, gyroscope, accelerometer etc. Thus testing on mobile phones or tablets is easy. An emulator is included as well as a simple debugger of the application.

In Fig. 2, the videoconference is tested using WebRTC [4]. The system is based on open source, or free software to keep cost low. However, a lot of code changes were required to make the system functional.

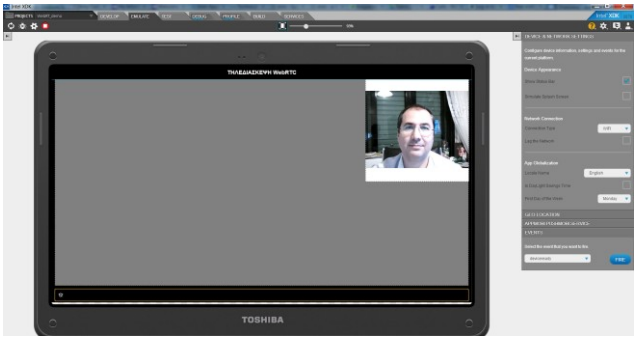

Figure 2. Rapid prototyping using Intel XDK

Although developing the system as a web service, allows its easy update, it also poses several disadvantages. The main disadvantage, is that login to the system is required, in order for each user to be identified. However, this process is not desirable for the elders. On the other hand, automatic login might result in an undesirable time that the system is not responding and this may frustrate elders. Thus the next development phase is to port the application directly to the HDMI TV dongle as a standalone application, customized to the patient-user needs.

A. *Developed Application*

The application must have a simple and easy to use interface. In Fig. 4 the look and feel of the application is illustrated. Fonts have large size; screen colors are picked from a basic palette offering high contrast, while all icons are large and placed at the left side of the screen. An option may be selected either by moving a mouse (in our case an airmouse) or by pressing a number from the keyboard (alternatively buttons from the retro phone developed especially for the system).

It can be noticed that the desirable options, which were described in a previous section, have been implemented, namely weather forecast, videoconference and medical monitoring. Weather forecast is achieved using a free widget

available for webs. Location is automatically identified by the IP of the router and selected by default, offering a three day forecast. Videoconference is performed using WebRTC (as mentioned before), however other solutions are currently evaluated and considered for inclusion in the future.

Figure 3. Screen shot from the prototype, including weather information, WebRTC videoconference and health monitoring

B. *Retro Phone*

A cheap tablet was used for prototyping reasons, with a custom made application offering the typical phone buttons. The user presses the buttons and depending on the screen, the user is either selecting something from the main screen (e.g. weather forecast), or the user is actually calling someone, enabling videoconference. At this point, we must state that each contact is associated with his/her phone number instead of his/her username, because elders are more familiar with this than scrolling down a list to find a contact. Thus, to ease usability, exploiting at the same time day-to-day activities, the phone was selected to be used as the system's input instead of a mini keyboard or a mouse.

A new prototype is currently under development, based on an Arduino board. This will reduce further cost, while the developed subsystem will be placed inside an actual retro phone.

C. *Custom Applications*

At this point, we may highlight another aspect of the proposed system. As mentioned in a previous section, the aim of the development team is to offer plugins in the future, extending the functionality of the system. For this reason, an application that is coupled with the measurements from an accelerometer placed on an elder's belt was developed.

A high value of acceleration indicates possible fall, which triggers several actions, such as sending a message to a relative, enabling the camera and call for videoconference an emergence number etc. This application is under development. More research results from other teams have to be exploited rather than create one more fall detection methodology.

D. *Overall Cost*

One of the obstacles for the system development was cost. It had to be kept low in order to be affordable, as a consumer product the elders. Since prototype costs are significantly higher than the final product, the cost of US $218 (Table I lists the parts used) is considered to meet the cost requirement. In this amount, no software development cost is included, since the selected software is free and open source. Considering also the development of a new prototype for the retro phone, further reduction of the cost will result by removing parts of the first prototype (e.g. the tablet and the headphone set).

TABLE I. PROTOTYPE SYSTEM

#	**Total expenses in detail (Q2/2014)**	
	Description	***Cost ($)***
1	HDMI TV dongle	59
2	Web Camera	25
3	Airmouse	30
4	Retro handset	24
5	Tablet	60
6	Other equipment	20
	Total	218

V. CONCLUSION

A low cost system aiming to assist elders to advantage from new technology was proposed. Although the main aim of the proposed work was to make interaction of the elders with technology easier, it collaterally benefits them in various ways. The main aim was achieved with the use of retro devices for HCI purposes, reducing significantly or even eliminating the training period. Collaterally, the elders that were monitored to assess this work were using the system daily, mainly to read the weather forecast and to communicate with their relatives or caregivers through teleconference. The degree of depression, since the loneliness sentiment seems to exist no more is left to be evaluated. Finally, the developed architecture remains open, allowing easy extension of the provided services. An application at its early development phase was described, highlighting the value of the proposed work.

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