

A Home Office for Users with Special Needs

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Abstract. Easy access to global communication infrastructures enabled a number of emerging applications that are rapidly changing our home/office concepts. Working-at-home is now increasingly common and able to provide relevant employment opportunities for many persons with special needs. This paper describes the work being done in the Portuguese side of an European HORIZON project, where an integrated home office environment for persons with cerebral palsy is being developed.

1. Introduction

The main concepts underlying the emergence of home offices are presented in the following section, followed by a description of the overall solution being developed under the Portuguese side of the ESTIA HORIZON project. The deliverables available thus far are a hardware infrastructure and an integrated user interface tool (including environmental control, AAC, telephone communication and access to Windows 95 applications), which are presented in sections 4 and 5.

2. The home office

Tele-working is frequently regarded with suspicion due to social isolation issues, but there are two good reasons to develop home office environments for persons with special needs:

1. Acceptance of working-at-home is growing exponentially in many professional areas [1] and this trend will not be reversed. Home offices will become common in the near future and it is important to consider the specific requirements of users with special needs as early as possible.
2. Social isolation is of concern to people who were used to commute to their jobs every day, but to all those who had limited ability to leave their homes tele-working can actually provide a very relevant contribution towards a much improved social, recreational and professional life.

This shift towards home-based businesses (the home being either the consumer end or the source of a service provider) can easily be inferred from technical reports normally accessible to experts in the field [2, 3], but even public clues such as Microsoft's international slogan (*Where do you want to go today?*TM) leave no doubt about this trend. This reasoning led to the background vision of the work to be done in the Portuguese side



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of the ESTIA project, which was stated as follows: "To combine home office technology and assistive technology solutions in order to set up a tele-working and continuing education environment for users with cerebral palsy" [4].

3. Overview of the complete system

The main user requirements that were identified implied integration of the following system components: environmental control, augmentative and alternative communication (AAC), telephone communication and access to Windows 95 applications. Moreover, access to any of these system components should be possible using a single switch as the input device and a common "look and feel" user interface. This system includes a hardware infrastructure that should be present if the complete system functionality is to be available. The next section will describe the role of each system component in terms of the user requirements to be met.

4. The hardware infrastructure

The hardware infrastructure consists of a PC equipped with standard sound and modem cards, connected to a distributed environmental control system based on the CAN bus (the Control Area Network bus was initially developed for the automotive industry but is nowadays used in many other areas). The relationship between each system component and the user requirements described in the previous section can be summarised as follows:

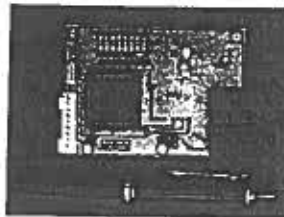
1. The CAN bus implements the home network used for environmental control. Each device is connected to a small board, shown in figure 1.(a), which contains all control and communications resources. These boards are inter-connected using a twisted-pair cable, shown in figure 1.(b). The actual driver for each device actuator (windows, doors, shutters, curtains, general purpose power sockets, etc.) is a small board with two relays, shown in figure 1.(c).



(a) CAN bus card.



(b) CAN bus and twisted pair.



(c) CAN bus and driver cards.

Figure 1: CAN bus cards and device drivers.

2. The standard PC sound card is used for AAC. The user interface (as will be described later) enables the selection of voice-output messages, represented on-screen according to the users' preferred symbol system (Bliss, PIC, PCS, etc.).

3. Telephone communication and access to a hands-free telephone
4. Access to any Windows 95 applications and requirements (connected to the PC and telephone communication)

The four areas referred to by the user. If the environment sound and modem card. Similarly, if no modem card. In the limit, when no CAN bus is used with Windows 95 applications.

5. The Magellan user interface

The main requirements (called Magellan) are the following:

1. Should enable single button operation
2. Must be easily adaptable to different users
3. A common "look and feel" user interface for control, AAC, telephone communication, and access to Windows 95 applications
4. No "software engineering" required; the specific requirements of the user get acquainted with the system

The basic Magellan user interface consists of five buttons scanned according to the user's requirements. The types of buttons are: Command buttons for AAC; Telephone button to launch Windows 95 applications; Menu buttons (menu structures can be of any level — or more complex); Sound button; and a "root" button. These five types of buttons are followed by a brief presentation of the user interface.

Command buttons

An example of an environment button is always the "root" button and to the previous menu and to the previous menu currently active during the "root" button in figure 1. A single beep, or any other sound selected by the user.

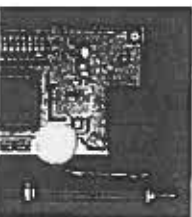
When the button represents the respective environment, a small binary file associated with the button is used.

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3. Telephone communication is enabled by the internal modem card in combination with a hands-free telephone (how to establish a telephone conversation will be described later).
4. Access to any Windows 95 application is accomplished by mouse and keyboard emulation and requires no other external device, besides the same input switch (connected to the parallel port of the PC) that is used for environmental control, AAC and telephone communication.

The four areas referred above are independent and may be combined in any way that suits the user. If the environmental control sub-system is not present, but the PC at hand has sound and modem cards, the three functional areas described last (2 to 4) will be possible. Similarly, if no modem card is available, only telephone communication will be excluded. In the limit, when no CAN bus / sound / modem cards are available, the user can only work with Windows 95 applications.

5. The Magellan user interface

The main requirements that were identified for the development of the user interface tool (called Magellan) are the following:

1. Should enable single-switch control and support multiple scanning techniques
2. Must be easily adaptable to the special needs of each user
3. A common "look and feel" should exist for any of the areas supported (environmental control, AAC, telephone and access to Windows 95)
4. No "software engineering" skills should be required to customise the user interface to the specific requirements of each user or to enable incremental complexity as the user gets acquainted with the system

The basic Magellan user interface shows to the user a menu composed of a number of buttons scanned according to the specified scanning technique and speed. There are five types of buttons: Command buttons, used for environmental control; Message buttons, used for AAC; Telephone buttons, used for telephone communication; Application buttons, used to launch Windows 95 applications; and Menu buttons, used to move to another menu (menu structures can be made simple — single or multiple pages at only one horizontal level — or more complex — vertical / horizontal combinations in a hierarchical scheme). These five types of buttons will now be further described through actual examples, followed by a brief presentation of the customisation process for each individual user.

Command buttons

An example of an environmental control menu is shown in figure 2. The two upper left buttons are always the "root" and "parent" buttons, respectively used to move to the main menu and to the previous (one level up) menu in hierarchical configurations. The button currently active during the scanning process comes slightly forward (such as shown for the "root" button in figure 2) and the transition to the next active button is accompanied by a sound selected by the user (this sound can actually be the name written below each button, a single beep, or any other sound).

When the button representing the required action is active the user will press the switch and the respective environmental control command will be executed (Magellan will fetch a small binary file associated with the selected button and will output its contents through the

serial RS-232C port to the CAN interface board). The Magellan interface can be made compatible with other environmental control technologies by adding a new library with the proper binary file drivers.

Message buttons

An example of an AAC menu is shown in figure 3. Selection of any AAC button will cause the respective voice-output message to be output. The same interface procedure as for environmental control is used, a message being output when the required button is active and the user presses the switch (Magellan will in this case fetch the audio file associated with the selected button and dump its contents to the sound card).

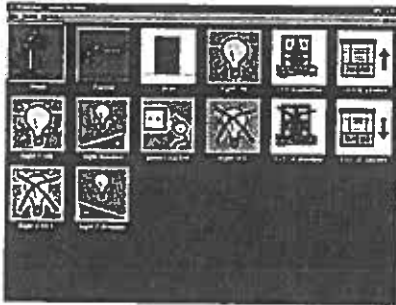


Figure 2: Example of command buttons.

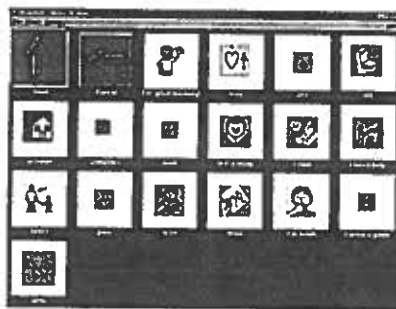


Figure 3: Example of message buttons.

Telephone buttons

Telephone menus can actually be a mix of telephone and AAC buttons, such as shown in figure 4, or exclusively composed of telephone-type buttons. Pressing the switch when a telephone button is active causes the respective telephone number to be dialed (Magellan uses the telephone number associated with the selected button to establish a telephone connection through the modem card and immediately transfers the call to the external hands-free telephone). When the user requires AAC help, AAC buttons with the most frequently used messages can be added in the same menu, therefore avoiding the need to move from the telephone menu to an AAC menu.

Application buttons

Figure 5 shows a menu composed of application buttons, which will launch the corresponding Windows 95 application when selected.

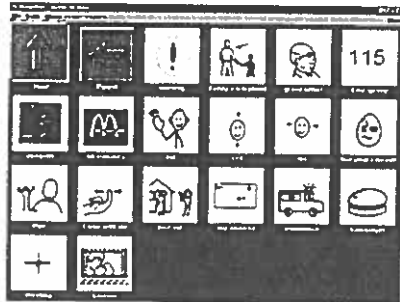


Figure 4: Example of telephone buttons.

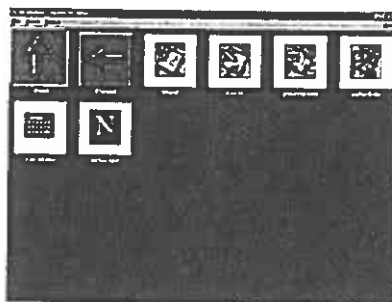


Figure 5: Example of application buttons.

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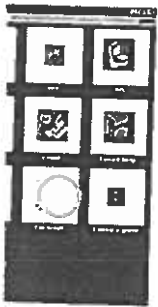
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Application buttons enable the users to run any Windows 95 software. All common tools in an office environment (text processing, spreadsheets, etc.) can be run. Figure 6 shows an example of text processing with Word. Notice that Magellan included a keyboard emulation window at the lower left on the screen, where the same scanning techniques are used to select which character to type. Typing alone would not suffice, so Magellan supports mouse emulation as well (started when the arrow in the top-left corner of the keyboard emulation is selected). When mouse emulation is selected, a small rule in the lower left of the screen appears, such as shown in figure 7.

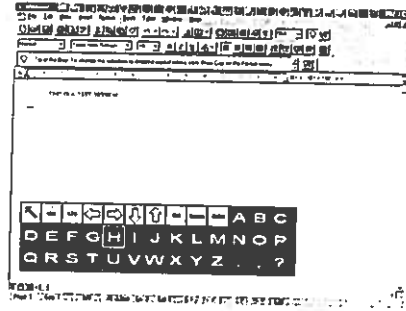


Figure 6: Keyboard emulation with Magellan.

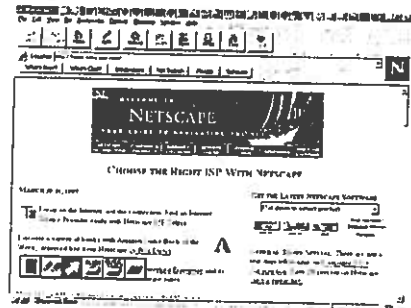


Figure 7: Mouse emulation with Magellan.

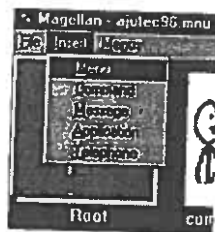
The left button (door) in the mouse emulation rule exits to the calling application menu in Magellan. Selecting the footprint button indicates that the cursor should be moved along the direction pointed by the arrow button (third from left). When the arrow button is selected, the arrow will start to rotate (indicating the new cursor movement direction) until the switch is again pressed. Buttons for click (simple selection) or double click (execution) follow in the rule, while the rightmost button again reverts to keyboard emulation mode.

Menu buttons

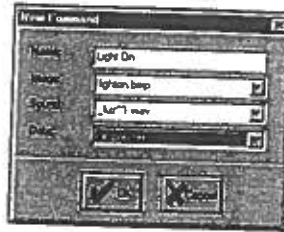
The final type of buttons considered are the menu buttons. Selecting a menu button will "call" its associated menu, which in turn may have buttons of any type (including new menu buttons).

User interface customisation

Adding buttons can be done using the Insert pop down menu illustrated in figure 8.(a). As an example, adding a new command button can be done by simply selecting Insert Command in this pop down menu, which would cause the dialogue box illustrated in figure 8.(b) to be displayed. The user will write the name of the button (this name will appear below the button) and select from the available libraries the desired icon (to be shown in the button), sound (to be used during the scanning process) and data (to be sent to the RS-232C interface for execution) files.



(a) Insert pop down menu.



(b) Dialogue box for a new Command button.

Figure 8: The Insert pop down menu and Command button dialogue box.

Any set of menus built for a specific user can be saved, or incremental changes in complexity recorded under new file names, making it very straightforward to customise Magellan to any user. The *File* pop down menu enables these operations.

The final steps in customisation are grouped under the *Menus* pop down menu. This pop down menu enables the user to adjust scanning speed or scanning technique, as well as to edit the properties of an already existing button (for example, to change its associated icon).

6. Conclusion

Although an initial evaluation phase has already been carried out at the Cerebral Palsy Rehabilitation Centre of Porto (with positive feedback from therapists and users who were involved in the early field trials), the main evaluation phase will only start following the installation of a complete system at the Portuguese Association of Cerebral Palsy (APPC) building in Porto.

All experimental sessions conducted thus far took place using the set up shown in figure 9, which implements a complete system with a small number of external devices (power socket, on/off and dimmer lights, door, window and shutter actuators).

Besides the evaluation efforts, the other areas of current work are on the development of libraries to support additional environmental control technologies and on the development of a set of distance education courses in home office tasks and tools.

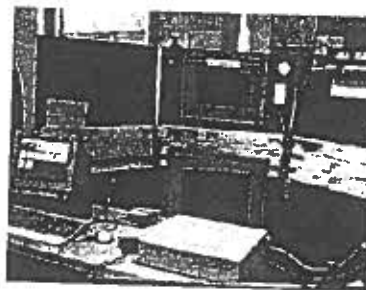


Figure 9: The trial area in the Cerebral Palsy Rehabilitation Centre.

References

- [1] Mark Tipton, *Persuading Builders to Prewire for the Information Superhighway*, CES Habitech, Orlando, 1996.
- [2] Liz Mandeville, *Towards the Superhome: Bringing Home the IT Revolution*, RMDP Limited, 1995, ISBN 0 907923 31 3.
- [3] Michel Rubinstein, *L'impact de la domotique sur les fonctions urbaines*, Fondation européenne pour l'amélioration des conditions de vie et de travail, 1993, ISBN 92 826 6310 8.
- [4] J. M. Martins Ferreira, R. M. Brito, M. Santiago, M. Lourenço, *Integrated access and control in a teleworking environment*, CSUN Technology and Persons with Disabilities conference, Los Angeles, 1997.

1. Introduction

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