Control Application for Smart House through Gaze interaction

Keywords
Domotics, eye tracking, head tracking, multiple layout application, usability

Introduction

Research community has to face many challenges in the smart house system development: interoperability, communication, security, hardware, interface, etc. The biggest challenge probably is to maintain the focus on the user as the ultimate target of this intense effort.

One of the main aspects in the definition of the quality of life of a human being is autonomy, that in people with disabilities is often strongly compromised. This paper proposes an environmental control application, that works with domotics and eye tracking systems, for enabling people with severe motor diseases to interact independently with the home environment that surrounds them.

System Architecture

In order to completely control a domestic environment through gaze, some facilities are necessary for transforming user glances into commands and for physically actuating such commands.

Two main technological components are needed: a gaze control system and a domotic house. The gaze tracker follows the user movements and maps these movements to proper actions, by means of a control application. The domotic house executes the actions, closing the forward link of the user-home interaction loop. In the opposite direction, the house senses the environment and communicates its state to the control application which manages such information, possibly warning the user and requiring actions when necessary.

The main peculiarity of our system is independent from both smart home and gaze control devices of specific platforms. The system architecture (see Figure 1) is divided in four sections:

- Handling smart home appliances (low level).
- Handling smart home systems (high level).
- Handling Gaze Control devices.
- Environmental Control Application.

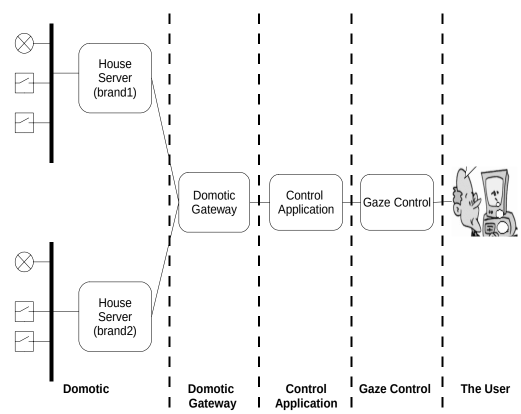

Figure 1. System architecture

Domotic System and Domotic House Gateway

There is a great deal of domotic system brands on the market: most of them adopt different standards for the communication buses, either proprietary, like the SCS by BTicino, or freely available (for association members) and widely supported like the Konnex standard, which is the result of a joint effort of more than twenty international partners.

A software component like a "gateway" that abstracts the physical configuration of the house and gets uniform access to various appliances is necessary to achieve interoperability amongst different systems.

The House Gateway has to provides three important functions for an house automation architecture:

- Independence from Domotic Brands
- Abstraction of appliances
- Home Intelligence

Unfortunately there isn't yet a standard for domotic appliances representation and for comunication protocols between control applications and house gateways. This standardization is one of the tasks included in the COGAIN project.

In our system we have employed a Domotic House Gateway (DHG) previously developed within our research group and described in detail in (Pellegrino et al., 2006). The DHG provides access to the description and to the control of the smart home system through a simple XML-RPC interface.

Gaze control

There are many gaze control systems either commercial or developed by accademic researchers. It's just recently, thanks to Cogain network, that researchers and productors of different commercial systems are working together to define a new universal standard for eye control applications.

Unfortunately nowadays few devices support the first standard release (Bates and Spakov, 2006), yet, an element that is conventional in most systems is the capability to control mouse cursor movements and events. Our enviroment control application uses infomation about mouse cursor movements and events in order to be compatible with most existing systems.

Environmental control application

Purpose of this software is to present to the users an interface where they can check the state of the various appliances and send control commands to the house.

The environmental control application communicates on one side with the DHG to obtain information about the state of the domotic home and to deliver commands, and on the other side with the Gaze control system through a "point and click" interaction.

The main feature of the control application is the dynamically resizable layout (see Figure 2). This characteristic meets two requirements: to support eye control systems with different performance and precision and to follow the possible aggravation of users' conditions during the progress of the disease.

When the user adopts a different application layout due to the disease evolution or just to use a different gaze control system, he or she shall not be compelled to learn a different way of interacting with the application. In other words, the way commands are issued shall stay the same even if the layout, the calibration or the tracking mode changes. For domotic control applications, the commands issued with such a gaze-based interface shall be similar to the ones issued by means of the standard interface, i.e., buttons, switches, etc. However, since the layout is constrained by the accuracy of the tracking system, which may change depending on the disease, the interface elements have been grouped by house room. This means that, when the user wants to switch on the kitchen light, he or she shall first select the room, i.e. the kitchen, then select the light object and finally confirm the desired change of the object state by clicking on a confirmation button. These three steps remain the same while the application layout varies.

Experimentation

Our test system uses Sandra as Gaze control software, which is based on a low cost webcam and can work both as head tracker and as eye tracker. Each of these two modalities offers a different precision and performance. The platform is described in more details in (Garbo and Corno, 2005). We have used the aforementioned DHG in a smart home that is part of a scientific and technological park maintained by C.E.T.A.D. and dedicated to promotion, development and diffusion of technologies and innovative services for rehabilitation and social integration of eldery and disabled people.

Conclusion and further research

This paper presented a Control Application that uses eye and head tracking as a means to allow not only communication but also interaction of severely impaired people with the environment that surrounds them.

Results are still preliminary, however they provide some positive feedback on the feasibility of the approach and on the capability of the application to improve the nowadays interaction between disabled users and houses. Several issues need further improvements, as the presented work is still under development. Future works on the Control Application will adhere to the to Cogain standard and will improve the user-application interaction in terms of responsiveness, providing as result a platform ready to be tested by end users.To set-up this more extensive experimentation campaign the authors are already collaborating with care-givers institute Molinette, in the context of the COGAIN European network of excellence.

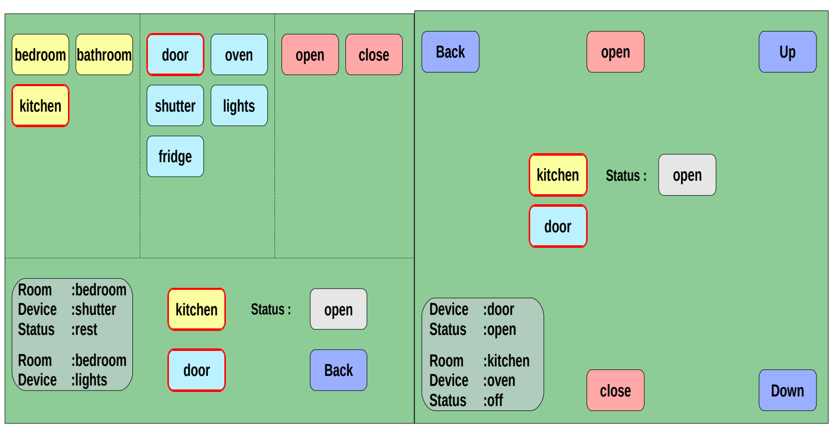

Figure 2. Differt layouts of control application

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