SMART DEVICES IN A TRAINING HOME FOR PEOPLE WITH DOWN’S SYNDROME: CASE STUDY OF “CASA SATELLITE”

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ABSTRACT

Through an analysis on disabled people data and because of a specific request of families and associations of disabled people in Italy, it emerged the necessity to design new home solutions. Theirs goals are the improvements of the autonomy and of the quality of users’ life in their own homes instead of in health care institutions.

CUnEdI of the University of Trento developed a methodology of participated interdisciplinary design for smart homes for disabled users.

This paper refers to the case study called “Casa satellite” a home solution designed for people suffering from Down syndrome. “Casa satellite” is a pilot project which aims to educate the users to an independent living by mean of a training period in the experimental dwelling. This apartment combines accessibility and automation system in order to facilitate the activities inside the home, to assure safety and security, to permit the remote connection with assistance services.

Key words: Disabled people, independent living, Down syndrome, mental retardation, automation systems
Introduction

The disabled persons express a wide range of requirements that are closely linked (or related) to type of disabilities and disability degree, life-context, expectations. In order to meet these needs solutions that facilitate the quality of life (of the user on the whole), the accessibility, the safety and security, the autonomy, the social inclusion, the social and health support are required.

The answer is an integrated and personalized design of dwellings characterized by environmental contextual factors facilitators, according to the ICF acceptation, that is: furniture, aid and new technologies (Home Automation, Assistive Technology, computer science, telematics) to help the disabled people to carry out the domestic activities assuring a high level of safety and security.

But the only technology is not enough. For some disabilities typologies, in particular for the cognitive disabilities, in addition to integrated and personalized design, training is required in order to prepare and guide the users for the use of the new technologies.

We do not forget that the main features of the technologies aids are the simplicity of use and ergonomics so that to be accepted and used.

The design of these solutions entails a deep knowledge of the users because it is necessary to identify all specific requirements that the technological solutions must meet in terms of both function and ergonomics of the interaction.

CUnEdI (Centro Universitario Edifici Intelligenti - University Center for Intelligent Building) of the University of Trento is carrying out a research activity in order to define and verify a design methodology for housing solutions with home automation that can supply the needs of the different types of disabled people (motor, sensorial and cognitive).

This paper describes the case study “Casa Satellite”, a training apartment with home automation technologies for young persons with Down syndrome.

Persons with Down Syndrome: Deficit Characteristics and Future Life Expectancy

Down syndrome or trisomy 21 is a genetic disorder caused by the presence of three 21 chromosome instead of two.

The condition is characterized by a combination of major and minor differences of body structure (of skull, face, ears, hands,) and sometimes it is accompanied by a reduction in tonus. With these anomalies are associated: growth retardation, a retardation of the motor development, language deficit, a moderate or severe degree
of mental retardation. Today it is a well-known fact that the many phenotypic characteristics, except for the mental retardation and the muscle hypotony, are variable and they can even are not present. Between 30% and 60% of individuals with Down syndrome is suffering from congenital heart defects.

At the present time the incidence of Down syndrome is estimated at 1 per 1200 births. With the progress of the medical science and with bigger cares dedicated to people with Down syndrome, the life expectancy is longer and in the future it will still increase. Today the people with Down syndrome can live longer than 60 years and 38000-40000 persons with Down syndrome live in Italy. The 61% of these are over 25 years of the age.

In addition to the variable level of mental retardation the persons with Down syndrome can have even impairments of vision and hearing. Therefore in people with Down syndrome the impairments can be in:

- cognitive abilities (abstraction capacity, problem-solving capacity, attention capacity, short and long term memory, time and space orientation capacity, capacity to plan the sequence of events);
- sensorial abilities;
- communication and language abilities;
- social and personal autonomy;
- effective and relational abilities.

Until recently, many people thought that the persons with mental retardation are always dependent on the parents, but today it is possible to meet young people with Down syndrome in the schools and in the parks, adults that work and move oneself by public transport.

It is possible to assist the growth and the development of the children with DS by means of individuals programs to be carried out together with the family and the professional educators. In this way they can reach a good degree of personal autonomy and they can learn to cook, to move and to make shopping in order to take care of oneself. Further the young people and the adults can learn a trade and they can be involved in the job in capable and productive way.

Usually that happens because some associations support the families and work in the field of cognitive disabilities.

ANFFAS (Associazione Nazionale Famiglie Fanciulli e Adulti Subnormali - National Association of Families of the Young and Adult Mentally Disabled People), for example, is an important Italian association that looks after the rights of intellectually disabled people and families. It is a nationwide organization spread in all major cities consisting of Local Divisions and Regional Committees. In particular ANFFAS operates in the sectors of education, professional training, sport and free time.
At the present time, the main worry of parents and relatives of people suffering from Down syndrome is the future of their disabled son/daughter when they will be no more able to take care of them because of age or death.

Which solutions are better to solve the problem “after the death of parents”? Are the adults suffering from Down syndrome able to live independently in safety and security conditions? Is it possible to give them an alternative solution to transfer in health care institutions?

Today we can give to people with Down syndrome the opportunity of residence training periods in experimental houses that are suitably designed and technologically equipped, in order to facilitate the activities inside the home (domestic actions), to assure safety and security conditions, to permit the remote connection with assistance services.

CUnEdI developed the design of a training home called “Casa satellite” (“Satellite Home”) for young people suffering from Down syndrome. It combines accessibility and technological innovation in order to allow an independent living.

This design is included in a large plan for future realizations that has been sanctioned with the subscription of a program agreement among local companies specialized in commissioning and construction of smart devices, CUnEdI and social welfare cooperatives. This agreement is coordinated and promoted by the Autonomous Province of Trento (Service for Social Policy).

The Project “Casa Satellite”

The training apartment “Casa satellite” (Satellite House) is an idea of the ANFFAS Trentino Onlus association. Interpreting needs and hopes of the families of people with Down syndrome, this association is working to give a concrete solution to problem concerning the future of the people with mental retardation after the death of the parents.

The project “Casa satellite” is born as evolution from another project called “Cresciamo insieme” (Grow up Together). It is a program for adolescents and young people with mental retardation in order to follow their maturity, assumption of responsibility and development of a grown-up identity.

With the “Cresciamo insieme” program, groups of young people with Down syndrome aged between 17 and 25 years pass together some days and nights inside a centre located in Trento. Here boys and girls have the possibility first to learn and then to do alone the housework (to cook, to smarten up the kitchen, to clean, to wash, to do the washing, etc.) and to organize their free time with a living autonomy.
compared to their family of origin. In this centre boys and girls are continuously. The social worker (professional educators and psychologists) will follow the user behavior by creating atmosphere of welcome, familiarity and participation.

From positive experiences of “Cresciamo insieme” it emerged that many young people with Down syndrome have the pre-requirements to increase the autonomy in the daily life inside the training home “Casa satellite”.

The aim of “Casa satellite” is to accommodate mixed groups of young people with Down syndrome in order to teach them “specific competences functional to: daily life, planning of free-time, organization of external activities that entail relationships with new persons, use of public transport and participation to social life”. In order to reach this aim the home automation plays a prominent role.

Dwelling and Users

The apartment selected for the “Casa Satellite” research project is located in Trento, at the first floor of an ITEA (Istituto Trentino Edilizia Abitativa – Institut for the Housing in the Autonomous Province of Trento) house, and has a surface of 71 mq (Fig.1).

The building location is connected by walking from the centre “Cresciamo Insieme” (Grow up Together) and it is served well by public transports.

The flat includes the following rooms: entrance/living room (25,27 mq), kitchen (8,92 mq), corridor 3,44 mq, bathroom 6,43 mq, two bedrooms (13 mq and 13,57 mq) and two balconies.

The first users selected for the program “Casa satellite” (Satellite house) will be 16 young persons affected by Down syndrome, those aged 19-28 inclusive, with a low or medium level of cognitive disability. They have been selected from the “Cresciamo insieme” program. They usually live at home with their family and almost everybody works in the morning. They will live some periods in the experimental flat “Casa satellite” divided in 4 mixed groups (2 boys and 2 girls), alternated by some periods at home.
In order to get global and not local results, the CUnEdI used for the “Casa Satellite” dwelling project a participated and interdisciplinary design methodology that involves directly and actively in every design phase: users, in order to improve not only their final expectation but also the autonomy level and the quality of the life and delegates of different fields (health, social aid, construction, technology).

The methodology has been divided in six phases: users need analysis, organizing of the space in environments, preliminary design, check of preliminary design, final design, experimental monitoring. This methodology has been described in detail in “Frattari A., Dalprà M., Chiogna M. Smart home and architecture: the case study of dwelling for people with cognitive disabilities, XXXIV IAHS World Congress on Housing Sustainable Housing Design Emphasizing Urban Housing September 20-23, 2006 Naples, Italy”.

**Automation System Design**

*Figure. 1* The building and the flat of “Casa Satellite” in Trento
In order to know deeply the “Casa satellite” users and therefore to individuate their specific needs, the CUnEdI staff organized meetings with the social workers and the psychologist of ANFFAS, which usually take care of these people. These social operators wrote synthetic profiles of the project participants, in order to evidence the development level of the users in the following areas: cognitive abilities, language and communication capacities, autonomy levels, interpersonal and social abilities, affective and relational areas.

In order to choose furniture and automation system helpful for the users in daily domestic actions, the following criteria have been adopted during the preliminary design: *ergonomic shape, using safety and simplicity*.

Furniture and smart devices have been designed according with habits and movement/cognitive abilities of the users (Fig.2).

Figure 2  Architectural and automation system design for “Casa satellite”
Each furniture comes from a specific need, individuated and discussed with the ANFASS educators, which work every day in the care centre “Cresciamo Insieme”.

The smart devices and the scenarios of the automation system have been chosen and implemented in order to allow a higher users autonomy level and at the same time guarantee safety and security.

The automation system uses devices that can interact with the whole system independently from a central unit (spread intelligence system). The input devices are detectors and manual commands. The output devices are actuator for lighting control, motorized opening windows or doors, safety and security systems and so on. The communication medium used for the system of this case study is the twisted pair.

The automation areas included in the “Casa satellite” design are: Safety and Security, Communication Technology and Entertainment, Indoor Environmental Control (microclimatic conditions) and Personal solutions.

In particular the system has been subdivided in the following task areas:

a) Safety: fire, water and gas detection, motorized components for fixtures, active alarm for illness;
b) Security: entrance door detection, balcony access detection;
c) Communication Technology and Entertainment: phone, videophone, entertainment and communication through a video-conference system based on TV screen use;
d) Indoor Environmental Control: door, windows, shatter opening control, emergency lights control, electricity supply support (restart), room controllers;
e) Personal solutions: supporting tools for memory, spatial and temporal orientation, daily organization activities, in order to allow user with cognitive problems perform easily the basic daily activities.

The following sections describe synthetically the different scenarios, the technological devices and the user interfaces designed for this specific case study.

**Environment Entrance-Living Room-Kitchen**

For the security in the entrance room a front door control system has been introduced. It includes one finger print entrance control, which will record the finger prints of users, social workers (especially who will be reached by phone for emergence) and firemen. In addition it will be possible to open the entrance door by mean of a numerical code. The armored door lock will be electronically operating.
The design includes also one entry phone to record the images of the apartment visitors, so that it will be possible to check who rings the apartment bell and come inside. In the entrance room one camera will be installed to count the number of the persons in the flat. In this way, when nobody is more inside, the alarm system will be activated.

Magnetic contacts will be positioned on windows and doors in order to detect their opening status. One IR presence sensor will be installed on the adjacent balcony, as outside security control.

In the living room the main interface tool will be a touch screen that will be used as TV screen too. Simple command bottoms will be included too. The touch screen interface will contain graduated scroll bare to show to the user a visual temporal scan. The progressive coloration of the scroll bare will remember simply and intuitively to the users how long time they have before that the time of “mornings go out” is coming. Each user has to go out at different time, for this reason one different scroll bar for each, identified by a picture, will be provided. In order to advice that the time is up, a sound alarm will start: each user will choose a personalized music for this aim.

The touch screen will show also the task of each user in the flat management. A simple image (the user picture associated to his task action) will remember the daily personal domestic job. When the user finishes a task (to clean or tidy up the room, to wash linen, etc., as decided with the social operators), it will be confirmed pressing the picture on the touch screen.

The performed task will be recorded, in order to have a report of the personal experience of each user in the experimental apartment. This report will have both an educational value for the users that can understand how many planed tasks they accomplished and it will be a tool for the social operators to verify the progressive behavior improvement of the users using the flats utilities.

The social operators will implement the system simply and autonomously, deciding together with the users the daily program for the stay period in the smart home.

The touch screen will show the daily user appointment too, starting a time count similar to that one described before in connection to the “morning go out” function (again a scroll bar will visualize the temporal scan to advise in advance that it is necessary to go out to reach the appointment location).

Each alarm detected from the input devices will start a visual signal on the main touch screen in the apartment and at the same time it will call the remote operators to advice about the specific problem detected.
The main screen will be programmed in order to signal and visualize the alarm condition (windows opening, gas presence, etc.). Both a visual and an acoustic signal will be provided. An automatic call system will advice simultaneously the operators at the call centre. For example the remote control system will show the opening/closing status of the windows at the daily call centre during the working day and/or to the community flat operators, responsible for the night time too. The ANFASS operators will fix with the system integrators the alarm scenarios and their implementation modality.

If the user will signal directly and manually an alarm or panic condition, he will press the emergency button, in order to call automatically the call centre.

The supervision system will record each alarm in a database, in order to monitor both the system faults and users reaction to the systems signals.

In the kitchen the safety design includes one water sensor and one smoke/thermo detector with two alarm levels.
The water alarm scenario includes two steps: the former shows the alarm condition to the users by means of an acoustic and visual signal on the main screen, the later activates an electric valve that close the water pipes.

The fire alarm scenario includes two different system actions.

The aim of the first one is to alert the people at home when something could start a fire before that the fire is in act completely. The fire detector will be programmed to detect a pre alarm condition: it will be activated for a defined indoor temperature and smoke quantity and it will give an acoustic and visual alarm. The pre alarm signal will appear to the users on the main screen and by mean of a light signal in each room, by the use of the light system flashing. The user should understand if it is only a false alarm (such example because a pen has been forgotten on the stove) and solve the problem. After that the call centre will be called, in order to check the reestablishment of the normal condition.

The second scenario will be activated when the fire detector indicates that the upper temperature limit has been reached. That means that a fire alarm is in act. In this case the local alarm will start and the remote call center will activate the fire department immediately (Fig.3).
The 2 bedrooms of “Casa satellite” will include 4 users and one social operator, when it is necessary. In particular the girl bed room will be equipped with a small sink in order to take the make up in the bed room instead of the bathroom.

The automation system design of the two bed rooms includes, for the user’s safety, a night light and a call push button next to the beds, in order to active the emergency call system. Magnetic contacts have been installed on the windows to guarantee the security (Fig.4).
Environment Corridor and Bathroom

The corridor between bedrooms and bathroom is without windows, for this reason night lights to illuminate the access to the bathroom will be installed with a timing switching on.

In order to indicate the users that the bathroom is engaged, an occupancy sensor will be installed that will switch on an outdoor red light. In this way it will be possible to understand when it is not allowed to access to the bathroom, without the use of a key that could be dangerous for cognitive users problems.

In order to indicate to the users in a simple and understandable way how much time they can still occupy the bathroom, again a visual signal will be used. This is a personal solution, as defined above, responding to the difficulty of the users to quantify time. The automation solution will include lights in different color that will turn on automatically in a sequential progression. The colored light sequence will start with the white and will finish with the red, using a chromatic scale significant for the final users. An acoustic signal will confirm that the time available to occupy the bathroom is up.

To start a fall alarm a colored cable will be installed beside the bathroom perimeter. If this cable will be stretched an automatic call will be activated to the centre operators and a visual alarm on the main screen apartment will appear (Fig.5).

Figure 5 Smart devices in bathroom and in corridor
Conclusion

The home automation can be a great help to disabled people in the daily life as long as inserted in an apartment accessible and adequately integrated with the assistance services.

In the future the home automation will permit further improvements for the well-being of the people with disabilities.

Today it is important to sensitize the people and the territory by means of concrete experiences of home automation for disabled people. It is necessary to promote and disseminate among disabled people and their families the technological solutions to insert in an apartment in order to give more autonomy strengthening the residual abilities, to assure safety and security, to improve the social integration.

It is important to choose furniture and smart devices in the preliminary design of these experiences according to the customs, the movement and cognitive abilities of the users.

Furniture, smart devices, and scenarios configuration of the automation system must satisfy specific needs discussed and agreed up with social worker, families and if it is possible with the same users.

The architectural and domotic design of “Casa satellite” is the third case study of training home elaborated by CUnEdI in the area of the research activities focused on the disabled people.

At the moment CUnEdI is planning a fourth case study: the architectural and domotic design for an apartment for 4 people with motor disabilities.

At the same time, the CUnEdI is working to define a scientific methodology to verify the validity of the elaborated designs promoting the role of the disabled persons both in the design phase and in the monitoring phase of the home automation solutions. In this way the disabled becomes tester and not only simply user.

References


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