Abstract—The maintenance of an autonomous, independent and active lifestyle is a crucial challenge shared by Western countries. These countries are characterized by an impressive demographic and epidemiological change. This challenge, if properly addressed, can represent an opportunity for companies and health services to innovate and propose new solutions to citizens. Indeed, at European level, the introduction of advanced home automation solutions proves how vulnerable people that require continuous assistance can improve their autonomy and quality of life. In this context, we present how the AUSILIA project can encourage the cooperation with the territory to enhance both the state care and the needs assessment with a focus on the development of new products and services.

Keywords—ambient assisted leaving, aging, well-being.

I. INTRODUCTION

In Italy, disabled people are more than 4 million and 3 million are seriously disabled. Elderly people, aged over 65 years, are more than 12 millions and 8 million are over 80 [1]. The number of aging people will increase in the next years with a strong rise in the 2020-2030 period. This fact, in the face of a population decline, will cause a socio-economic burden of the inactive part of the population on the active one. Moreover, families are increasingly in difficulties in taking care of elderly or disabled relatives.

In Western countries, healthcare is organizing in a manner that hospitals will treat only acute illnesses, while chronic aspects will be managed on the territory [2]. Unfortunately, this is not always possible. Indeed, often, the main problem is that the patient’s home is not sufficiently safe. For example, a system capable to send a request of need or emergency is often missing. Another aspect is that hardly the patient’s home facilitates his/her social inclusion. This fact provokes a progressive isolation, with possible depressive contexts that can cause an increase of the assistance request.

In the literature, several studies in the field of domotic and service robotics for elderly and disabled have been done [3–8]. The main problem is how to find solutions that fit the specific needs. Given, from one side, the high variability of syndromes and diseases, environmental and personal contexts, and, on the other side, the high number of possible assistive solutions, it is necessary to think of personal solutions [9]. This approach is essential to optimize the cost/benefit ratio [10]. The process of detection and allocation of the various aids should then be based on personalized and specific studies for each single user. In such a manner, it is possible to design solutions that perfectly fit the individual needs in the most effective way.

II. THE AUSILIA PROJECT

Technology can help people with chronic disabilities to live in their own homes, leaving hospitalization as a last resort. This is the goal of the AUSILIA (Assisted Unit for Simulating Independent Living Activities) project [11], a joint project between the University of Trento and the local health service of the province of Trento. A main target of AUSILIA is the customization of assistive solutions for users with physical and/or cognitive impairments.

AUSILIA consists of a domotic apartment and a living lab, both realized inside the Villa Rosa hospital in Pergine, Trento (Italy). Users have the possibility to spent some days in the domotic apartment (Fig. 1) to try various aids during their normal daily activities. In this manner, users realize their limits and how aids and ergonomic and architectural solutions can solve some of their problems.

Fig. 1: The domotic apartment inside the Villa Rosa Hospital in Pergine, Trento (Italy).

The domotic apartment can accommodate patients with different cognitive and/or motor impairments and different needs. For such a reason, the apartment, as far as possible, is designed in order to cover various types of situations and a certain flexibility has been required. However, since the apartment is
too small to have all the possible solutions that are available in a normal house, a living lab of 400 m$^2$ was realized (Fig. 2). In this living lab, there are some prototypes of "environments" that are highly reconfigurable. In this manner, users can verify how they live with different types of configurations of the same environment, choosing the one that best fits their needs, improving their autonomy and quality of life.

![Fig. 2: The living lab with different reconfigurable environments.](image)

This makes possible to realize tailored projects, designing and producing custom architectural solutions and custom assistive components or devices (Fig. 3). The users can then adapt their own houses accordingly to these projects.

![Fig. 3: The AUSILIA paradigm inside the de-hospitalization process.](image)

The living lab can also be a great opportunity for enterprises that are interested in sponsoring their products and solutions. Moreover, they will have the possibility to have a real test bench, enabling an effective understanding of problems and a design that takes into consideration the proposed solutions.

### III. The Framework

The developed assistive technologies includes sensors and actuators to help patients in the daily activities. In particular, engineers and clinicians collaborated to do a requirement analysis of potential users. Fig. 4 shows an examples for some scenarios and the main activities that usually a user wants to perform in such scenarios. It was up to the engineers to translate such requirements into technological solutions to monitor the performance in carrying out such activities.

![Fig. 4: Examples of tasks that a user wants to perform in different environments.](image)

The apartment is overstructured with respect to the needs of the single patients. This will give the opportunity to the clinicians to evaluate and choose the solutions that best fit the specific needs. The provision of technologies includes active and passive systems. Such systems are installed in the environment or can be wearable accessories. Some examples are position sensors, domotic systems, special furniture, smart household appliances, communication systems, advanced interfaces to interact with the environment and safety systems. State of health of patients is monitored through wearable sensors (Fig. 5). Acquired physiological signals are ECG, respiratory signal, blood volume pulse (BVP), electrodermal activity (EDA), skin temperature and EEG.

![Fig. 5: A patient wearing the wearable sensors used to monitor physiological parameters.](image)
Particular attention has been paid to the interconnection modalities. The domotic apartment is equipped with technologies for the acquisition and the recording in real time of data. Such data concern the status evaluation of patients and their interaction with the environment and the various aids. The acquisition of such data has several arguments:

- provide a tool for the active monitoring in order to prevent possible health and safety risks;
- provide a basis for the evaluation of the facilities: in this manner, clinicians and designers can determine the solutions that best fit the patient’s needs;
- evaluate the degree of confidence acquired by the patient in using the various aids and his/her stress level;
- make an historical record on the use of the territorial lab.

This could be helpful for further analysis and research, such as identify possible models, repetitive situations and user profiles.

Examples of systems used for monitoring are cameras, occupancy sensors, pressure and force sensors, and fall detection sensors. Moreover, a smart system will analyze the acquired data in real-time. Such elaboration will provide automatically an interpretation of situations and behaviors. In this manner, useful information can be obtained, such as use level of the technological aids and facilities, and possible difficulties of the user to access specific areas or in the use of the aids.

Inside the laboratory, motion capture systems are also present. These systems are helpful to evaluate the body posture of the patient during the daily life or during specific exercises for rehabilitation.

The system for the data visualization provides a 3D interface in an augmented virtuality scenario (Fig. 6).

![Fig. 6: The augmented virtuality interface developed for an aggregate visualization of the parameters of interest.](image)

Through this type of visualization, the therapists have the possibility to merge the information already provided by their eyes with a series of parameters that are usually “hidden”. Examples are quantities regarding environmental interaction, such as 3D movements, interaction forces, weight distribution and object manipulation, or “internal parameters”, such as heart rate, respiratory frequency, blood pressure and sweating. Such parameters are rendered in an aggregate manner in an augmented virtuality animation. This type of data visualization enables, through the acquisition of the user physiological parameters, to estimate his/her emotional state, in the context of the particular situation under examination. This enables a fully empathic interaction with the clinicians. This is a revolution in the diagnostic methods currently in use for the physical/cognitive rehabilitation. Indeed, this methodology will increase the efficiency and objectivity of therapists and enable more effective rehabilitation programs.

### IV. Expected Results

AUSILIA offers a great opportunity for the development of new form of public-private cooperation. In particular, this project enables to move from a market mechanism based on the “technology push” approach to a “market pull” model. Indeed, the government will have the possibility to try and introduce technologies that are effectively meeting the user needs. On the other side, the business community will have the possibility to develop innovative products and verify their potential on the ground.

AUSILIA foresees important benefits in terms of development of new tools and services by local and national enterprises. The latter will have the opportunity to validate and enhance their products. Moreover, enterprises can gather new ideas and new technological challenges. They will have also the possibility to transfer the “know-how”, generated in the laboratory, in innovative projects. This territorial laboratory could also be a reference point for enterprises involved in the health sector; in particular for what concerns investments in research and development. This fact is due to the possibility to test and validate the various aids on the user, adopting an approach that is “user-centered”. Moreover, AUSILIA can contribute to the definition of standard and best practice in a field in which there are still gaps in the definition of rules, standard, compatibility, and interoperability of facilities.

From a research point of view, AUSILIA will effectively contribute to the progress of knowledge in the involved areas. This progress will not only interest the development of new technologies, but also the possibility to develop an interdisciplinary field of research. Indeed, the research will focus also on behavioral models of users and on their needs. Analysis will be performed on the interaction of the users with the environment, with the possibility to exploit in the best manner their residual capabilities, trying to recover impaired functions when possible.

AUSILIA will have also a great impact on the education and training of specialist staff. First of all, the project will create an increased awareness and knowledge about the availability and the features of the various technological aids. AUSILIA will help the staff to deal with the various tools and to be informed on the state of technology. The project will also create a space for the interaction among clinicians, technicians and producers. This space will enable a faster and more effective communication. AUSILIA will then offer to researcher and innovators the possibility to communicate, without intermediaries, with domain experts. This possibility will create the...
opportunity to have a mutual contamination in different fields: medicine, rehabilitation, cognitive sciences, ICT, mechanical and automation engineering, biomedical engineering, architecture and design.

The major impact of AUSILIA is in the healthcare context. The customization of the solution and the training that will be offered to disabled users will enable the possibility of a more autonomous life inside their homes. The benefit is double. Citizens will experience a better quality of life on one side; the government will see a reduction of the expenditures for health on the other. This fact is mainly due to a lower need to recur to hospitalization or to care services provided by specialist staff.

V. CONCLUSIONS

The AUSILIA project has a great potential. Its added value is due to interdisciplinary collaboration between clinicians and technicians. AUSILIA will enable to expand the set of possible aids that a person with cognitive and/or motor impairments can have. In particular, the various solutions will be designed in a manner that they will fit appropriately the specific user needs. Indeed, AUSILIA will enable to come up with new technologies that are customizable, implementable and adaptable to different situations in a low-cost manner. With this kind of approach, there will be a reduction of the burden on the health-care system, especially for what concerns the hospitalization.

AUSILIA will ensure the suitability of the proposed solutions. Patients and caregivers will have the possibility to try these solutions, in order to verify if the latter are really useful and capable to enhance the quality of life of users and of their relatives. The reduction of the health-care burden, the greater autonomy and safety, and the possibility to have more integration in the society will increase the well-being of the patients, of their families and of the community in which they live.

REFERENCES


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