Deploying AI for Healthcare & Active Aging. Experiences, lessons learned and open challenges.

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The goal of this abstract is to illustrate strong features and general lessons learned derived from the work experiences performed in the domain of Active Assisted Living over a span of almost 18 years. Through a retrospective overview of various research projects [1], the aim is to conceive guidelines and research directions highlighting challenges for the deployment of AI & Robotics solutions as a means to support older adults in maintaining their independence and improve their Quality of Life. The work considers key points that have contributed to increase the success of the innovative solutions grounding them on known technology acceptance models like the Technology Acceptance Model – TAM [2], the Unified Theory of Acceptance and Use of Technology – UTAUT [3], and the ALMERE Model [4].

A pioneering experience was the RoboCare project, in which the idea of monitoring older person's activities at home and trigger simple verbal interactions through the robot [5] was exploited to suggest healthy behaviors to the users. Beside the technological development, a strong attention was dedicated to the users involvement adopting a co-creation approach starting from the user requirements elicitation [6] to the system evaluation in laboratory setting [7]. The evaluation results highlighted that a robotic platform should be robust enough to guarantee a continuous use in real world conditions and should also support users in relevant and important situations. The relevance of Intelligent Environments that cooperate to have a more informed and contextualised knowledge of both users' and environmental status also emerged as crucial.

A slightly different problem was faced in the ExCITE project, where a telepresence robotic platform was mostly dedicated to the long-term cross-national experiments in real homes. Notable results have been a methodology for performing long-term assessment in ecological settings [8] and a detailed report on the robot features that have been synthesized to follow the many new requirements emerged during continuous use in real houses [9], which were not possible to assess with controlled experiments in laboratory. This experience strongly highlighted the importance of ecological and long-term evaluations of AI& Robotics solutions.

The GiraffPlus project, was grounded on both previous experiences. A robotic platform remained as front-end entity for the interaction at home with the older person, but also gathering data from environmental and physiological sensors using state-of-the-art AAL middleware [10]. The user-centered approach was also adopted to design comprehensive and tailored

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services for better supporting the users over time, by taking advantage of huge efforts for user requirements elicitation [11] and the integration of different devices and services [12]. A long-term experimentation in real houses was also carried out.

From these experiences the importance of integrating different technologies to provide intelligent services emerged together with the continuity of use as a key challenge, especially if the technology is intended to help fragile people. Additionally, a multidisciplinary approach resulted crucial to build solutions that are technologically solid but also well accepted by users. The participants also expected intelligent and proactive behaviours from the robotic intelligent solutions. Another key challenge is related to the users' unpredictable behaviours. As a consequence, robotic solutions should be aware of the uncertainty concerning Human–Robot interactions and carry out continuous assistance in a robust and adaptive way. Robustness and reliability of robotic solutions are crucial in daily-living scenarios and the autonomy level of a robot should take into account the possible dynamics of human users in order to guarantee continuous and reliable assistance. More recently, the SI-Robotics project is focused on the design and development of modular solutions based on collaborative assistive ICT robotics with advanced abilities to support humans in healthcare services. The scientific objective is to investigate and implement technological solutions easily adaptable to assist elderly people in daily living activities and to assess the progress of their physical and cognitive decline, i.e. cognitive frailty, dementia, mild cognitive impairment, etc., thus enabling specific challenges for early diagnosis, objective assessment, therapy control and rehabilitation. The goal is to pursue the integration of different AI technologies to enrich autonomy of robotic solutions and support continuous and contextualized assistance. Additionally SI-Robotics can be used also as a supporting tool for caregivers and health professionals. In [13] the system is proposed as a means to help physiotherapists during the rehabilitation programs for Parkinson patients. The integration of Semantic and Planning technologies allows robots to interpret environmental data, build abstraction about an assistive context (e.g., the activity a patient is performing inside her house, during a training program or her physiological state) and proactively set/decide assistive objectives that can be autonomously achieved through the synthesis and execution of suitable actions. The integration of Machine Learning (ML) technologies allows also a robot to learn from experience and consequently dynamically adapt its assistive behaviors over time according to the specific needs of the considered scenario. In the case of daily assistance, for example, we have recently integrated ML to learn the habits of a patient and integrate a predictive model of patients' behaviors into the *sense-reason-act* loop. On one hand, this supports a better optimization and adaptation of the assistance. On the other, it enables recognition of deviations of patients' behaviors from "known habits". Personalization and adaptation of robot behaviours emerged as paramount: general skills and assistive capabilities of robotic solutions should be tailored to the heterogeneous needs and interaction features of assisted end-users. Safety of robot technologies should also be considered when deploying them in real-world scenarios.

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