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Angelo Costa
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Personal Assistants: Emerging Computational Technologies

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Personal Assistants: Emerging Computational Technologies

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Preface

It has been shown that the quality of life for people remaining in their own homes is generally better than for those who are institutionalised. Moreover, the cost for institutional care can be much higher than the cost of care for a patient at home. To balance this situation, efforts must be made to move the services and care available in institutions to the home environment. Thus, society poses new challenges, demanding systems that overcome this issue.

Personal assistants (PAs) are a relatively new concept, advancing the Cognitive Orthotics concept, which is only focused on direct assistance to people with cognitive or physical disabilities. The aim is to expand the Cognitive Orthotics area to include complex platforms that include sensors, actuators, monitoring abilities and decision processes.

PA domain contains technologies such as cognitive assistants, multi-agent systems, robotics and applications (such as e-health and e-learning), among others. Essentially, PA is focused on people and their disabilities, providing tools that best fit them using personalisation methods. They have been typically developed to perceive the intrinsic mechanisms of human cognition such as reasoning, learning, memorising, acting and adapting; to discover the thought process leading to each decision; and to build systems that can emulate those thought processes and make decisions or suggestions.

PA can range from a medication reminder to a messaging system that connects its users with their relatives. New developments like the Internet of Things and the increasing amount of computing power that hand-held devices have allowed the development of environments that were until now unavailable through embedded systems. Therefore, there are a lot of implementation options open for development on this area. This book is intended to provide an overview of the research being carried out in the interdisciplinary area of personal assistants and cognitively inspired systems.

The contents of the book were divided into the following parts: Introduction, Reasoning, Health, Personalisation, Robotics, Ethic and Social Issues.

The Introduction presents an overview of the area and the projects that constitute it. The Reasoning presents the knowledge processes that affect PA. The Health

presents application of PA in health environments. The Personalisation presents solutions that are directly related to how the PA can adjust to the users. The Robotics presents application of PA through robotic systems. And finally, the Ethic and Social Issues present the legal perspective of how the PA affects the society.

This book counts with international contributions, from countries such as Argentina, Republic of Colombia, Russia, Spain, Portugal, the USA, which provide different perspectives elated to their own culture, being composed by 12 chapters.

In closing we would like to thank the reviewers who helped to increase the excellency of this book.

Braga, Portugal
Valencia, Spain
Braga, Portugal
May 2017

Angelo Costa
Vicente Julian
Paulo Novais

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Part I

Introduction

Chapter 1

A Survey of Cognitive Assistants

Angelo Costa, Paulo Novais and Vicente Julian

Abstract Cognitive Assistants is a subset area of Personal Assistants focused on ubiquitous and pervasive platforms and services. They are aimed at elderly people's needs, habits, and emotions by being dynamic, adaptive, sensitive, and responsive. These advances make cognitive assistants a true candidate of being used in real scenarios and help elderly people at home and outside environments. This survey will discuss the cognitive assistants' emergence in order to provide a list of new projects being developed on this area. We summarize and enumerate the state-of-the-art projects. Moreover, we discuss how technology support the elderly affected by physical or mental disabilities or chronic diseases.

1.1 Introduction

The term Personal Assistants (PA) is originated from the Ambient Assisted Living (AAL) area that encompasses the advances in the ICT area that are focused in providing direct care on activities of daily living and related tasks. The AAL area focuses in technologies that provide healthcare, assistance and rehabilitation to elderly or disabled people (with cognitive and physical impairments), promoting independent living, active aging and aging in place. Therefore, the need for the distinction is required due to the fact that not all PA technologies belong to AAL and vice-versa. Recently PA have gained traction and there are several projects with interesting results.

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The need for projects on these areas comes from the increasing numbers of elderly people that need technological solutions on their daily lives [38]. Most of the elderly are fragile and need assistance to perform certain tasks. While most try to overcome these issues however they can and at great physical and psychological cost, some are unable to perform those tasks at all. Moreover, population aged 65 or older is projected to increase from an estimated 520 million in 2010 to nearly 1.5 billion in 2050 [38]. With the growth of elderly population comes the increase of mental and physical diseases like Alzheimer, dementia and mobility problems.

Population Reference Bureau [27] states that about 20 million North Americans assist elderly people performing daily activities, and that 70% need constant care. Monetarily speaking, in 2010 the spending in care of people with dementia ascended to 604 billion dollars, and with the increase of population its expected the increase of costs [38]. The health-care costs dedicated to dementia patients is estimated to be in the UK roughly £26 billion a year [26]. Two-thirds (£17.4 billion) is paid by people with dementia and their families, either in unpaid care or in private social care. Thus it is expected that the continuous increase of the elderly population will produce an economical disadvantage to their families and society.

One way to address this issues is with the use of technological devices that are able to help and simplify the execution of daily tasks. Low cost health-care systems can be built to diminish the burden of the caregivers with minimal transitional periods and with a high level of usability. Technological devices can help to break social and physical barriers that elderly people and caregivers have and enable independent living with a high rate of success.

Governments have already observed that these advances can be very advantageous. The European Union has and keeps promoting and funding projects on this area [14] through several calls to action.

Also, there is the European Innovation Partnership on Active and Healthy Aging (EIP AHA) that is constituted by several actors that work in conjunction to propose new ideas and pursuit technological developments directed to the elderly population; it aims to continually increase the levels of the elderly health condition by 2020 [15].

In terms of policies and protocols, there are some projects that tackle those issues through compilation of information on existing services and private and public initiatives, and conduction of representative surveys within the elderly population.

The AALIANCE project [33] built a guideline for development and research in the AAL area, as well as some policies that should be implemented at the European level. It is clear that there is a great interest in the PA and AAL area, where state of the art advances are currently being produced.

This work aims to provide an overview of the cognitive assistants inside the PA area, focusing on technologies and approaches for aging population in home environments. More specifically, we will present the concept and usage of cognitive assistants, which are constituted by platforms, services and tools that help the users overcome their cognitive disabilities through discreet and ubiquitous devices.

This chapter is structured as follows: Sect. 1.2 presents the cognitive assistants projects and their setting in the PA area; Sect. 1.3 presents the conclusions.

1.2 Cognitive Assistants

Cognitive Assistants (CA) are well integrated in the PA area and constitute a larger portion of that area. The CA have as social goal the production of tools that help people with cognitive disabilities to perform activities of daily living. Therefore, most of the advances produced on this area are software platforms, as the target users do not have any motor disability or only have mild motor disabilities caused by their psychological impairment.

Projects on this area seem to move towards a unified system that is able to interconnect to external services and create an extended technological environment [20]. This environment will be greater than the sum of the parts due to the possibility of data and sensor fusion, thus making available complex information that otherwise was unavailable. As a toy example, and for easy envisioning, we can take two sensors that when not unified could bring a lot of problems that are the smoke and flood detection; if there is a fire the sprinklers will be activated, the flood sensor will be activated and stop the sprinklers thus allowing the fire to spread; this process would be in cycle until one of the sensors stopped working. Therefore, with this example we can observe that interconnected systems can build interesting information when working together.

The following projects are a display of what is being developed currently conceptually and architecturally. They are a small sample that serve the goal of presenting a heterogeneity representation of solutions within the CA area.

1.2.1 DayGuide

The DayGuide project [3] aims to provide reminders associated to locations and guidance, a social platform for share and organization of tasks, through a mobile phone.

It is designed to be used by elderly people suffering from mild cognitive impairment (MCI) in an aging at home perspective. This project is fairly new and shows signs of being on an initial development phase, as showed by the interface on Fig. 1.1.

In terms of operation, the authors present the following toy example: “*When the person with dementia opens the entrance door, s/he receives specific reminders depending on time of the day, outside weather conditions and diary*”. The reminders

Fig. 1.1 DayGuide expected interface



are expected to be presented visually and well as aurally. Furthermore, their partnership has the ability to tap to an care-center environment with 60 persons that can be used for tests and validation.

1.2.2 Active@Home

The Active@Home project [1], which is very recent and currently does not present large developments, focuses on active people and how to maintain them active. Their approach is to promote game-based exercises designed for elderly people that engages them through dance and Tai Chi activities. The main goal is to avoid falls by keeping the elderly physically and cognitively exercised, improving their balance.

The technological implementation uses televisions (or large display devices) to show animated virtual characters performing the exercises, and capture the exercise execution by the viewers through wearable sensors. The information of the sensors will help to determine if there is an decay of the physical condition and if there is any undetected health problem. In terms of cognitive assistance, this project helps to detect cognitive illnesses and uses physical exercises to juggle their memory and remember previously done activities.

1.2.3 CoME

The CoME project [2], is a platform for monitoring and interacting with elderly people. The platform counts with wearable sensors to constantly monitor the elderly people and smartphones to visually interact with them and to receive self-reports from them. Moreover, the smartphone will be used to show tutorials about how to perform certain activities and be used by the caretakers to localize and receive health reports from their care-receivers.

In Fig. 1.2 is showed the architecture of the project. We can observe a complex CA platform that includes all the actors and several services that are aimed at maintaining and improving the cognitive status of the system actors. The platform is intended to be deployed at each elderly home, connecting them to a central service that provides information to the formal and informal caretakers, thus promoting the aging in place concept. Therefore, the platform also pushes the idea that it helps the caretakers by relieving them of the burden and stress of the constant supervision.

In terms of technological solutions, Fig. 1.2 shows that it is a typical client-server structure with a high volume of communications between them. It is not specified if there will be any local processing system for the wearables data or the smartphone data.

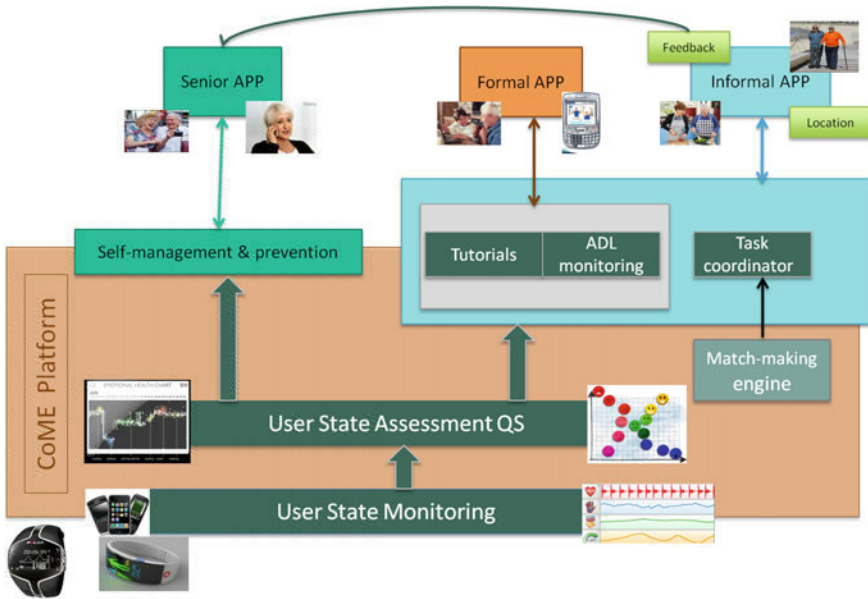


Fig. 1.2 CoME architecture

1.2.4 DALIA

The DALIA project [9, 39] is an wrapper for the ANNE virtual assistant, providing ANNE with the abilities of linear integration with external services and a service-oriented architecture. ANNE is a virtual assistant in the shape of a human-looking avatar endowed with speech and face recognition and speech capabilities.

The combined platforms result in an platform-independent virtual assistant, showed in Fig. 1.3, that has the following abilities:

- Easy communication with family and friends through the virtual assistant;
- Appointments calendar and automatic reminders;
- Documenting events and keeping memories;
- Emergency call and fall detection;
- Localisation of lost items;
- Health status monitoring and motivation for physical or mental activity tasks.

1.2.5 EDLAH2

The EDLAH2 project [4] aims to use gamification procedures on elderly people resorting to tablet technology. By showing appellative visual interfaces, as showed in

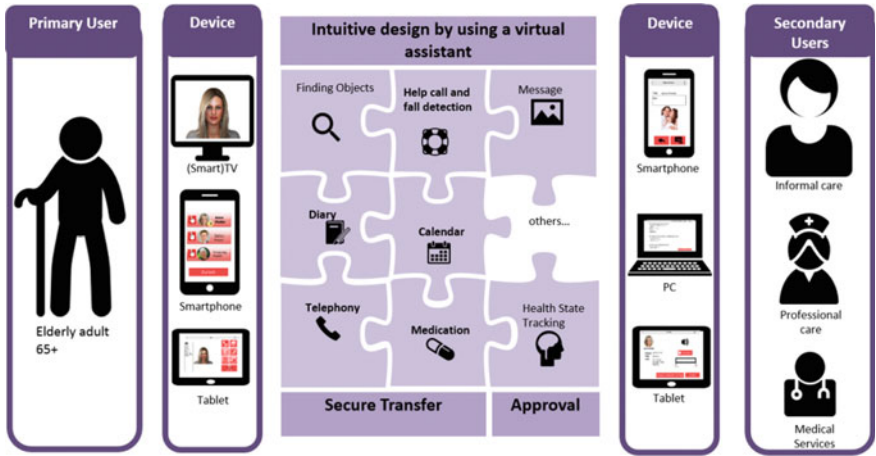


Fig. 1.3 DALIA architecture

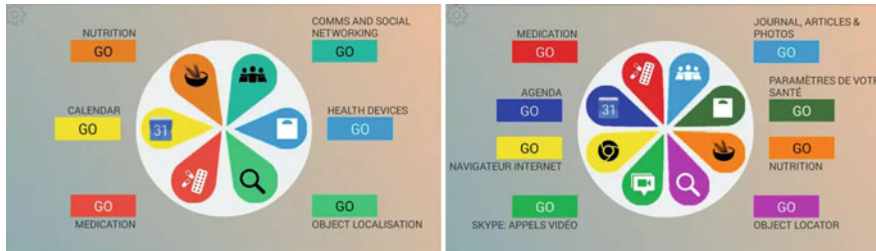


Fig. 1.4 EDLAH2 visual interfaces

Fig. 1.4, it helps elderly people to have a smooth interaction with normally difficult technology.

Being the evolution of the EDLAH project [7], it uses gamification to tap into the basic desires and needs of the user impulses, promoting status and achievements.

The objective is to be as appealing as possible and to have a greater incentive to be used, engaging elderly people into the use of new technologies, as seen in Fig. 1.4. Moreover, it may improve the mental health, physical health, social integration, and self-esteem. It will be employed positive reinforcement suggestions and messages, that cater to the user progress and imply further usage of the applications and tablet.

In terms of gamification the execution process will give awards gained by using other services, e.g. web browsing, games, visualizing photos, and those points will be put in a leader board constituted by a closed set of friends, or the general community, or just personal classification (if one wishes not to be compared).

This PA may be considered as active, as it requires direct interaction from the users for it to work and influence them. Nacke et al. [22] refer that casual and continuous gaming among elderly people using digital devices show a noticeable increase

in cognitive development and physical development. Thus this project is an assistant in terms of assisting the cognition health of its users.

1.2.6 *iGenda*

The iGenda project [10–13] is a cognitive assistant that focuses on elderly people and their caregivers through management of daily events and activities. The idea behind this project is to use technology to tackle the issues of forgetting activities and by remembering them to the elderly, they shuffle through their memories, thus exercising their cognition. Furthermore, the iGenda promotes playful activities (physical and psychological) that enable the elderly to have an active aging.

The iGenda works in two fronts: active aging and aging at home. By taking into account the users' profile and their health issues, the iGenda plans the appropriate activities to each user, being them more outgoing or more homely.

The idea behind using events and activities is supported by several studies that defend using activities and social interaction help to maintain the cognition levels and help stopping the Alzheimer's advance [5, 6, 16, 19, 25, 28–30, 34–37].

The iGenda also is designed to the caregivers, allowing them to manage the activities, schedule new activities or visualise the elderly vital signs (when a wearable device is used). Therefore, it decreases the caregivers' stress coming from the constant care-receiver monitoring and allowing them to monitor several people at the same time.

In terms of operation, the iGenda runs on smartphones or devices with web browsers and is transparent to the users, only warning them when there is an critical interaction required or if the system detects that the users are not performing the activity that was planned at that time.

The iGenda is implemented over multi-agent platforms that are modular and easily scalable. An overview of the architecture is showed in Fig. 1.5.

Currently the iGenda developments are in the emotion detection area and the persuasive area. The goal is to gather unbiased information from the users emotional state and how they respond to certain activities suggestions, and to justify using natural language and human concepts the reason why one activity was suggested over others through persuasion processes.

1.2.7 *M3W*

The M3W project [23, 24] aim is to develop a mental wellness tool for self-usage to measure and visualise mental changes and tendencies, and to give indications, alarms or reports This tool is directed to the elderly and their relatives, friends, and physicians.

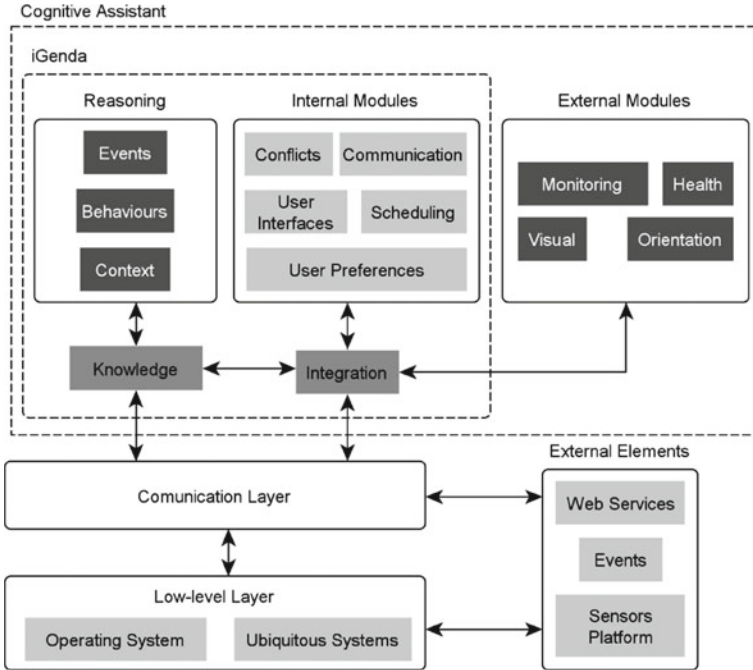


Fig. 1.5 iGenda architecture

The goal is to create an personal health record through historic values and show the positive or negative progression of the health condition.

To evaluate the users, this project uses cognitive games that are designed directly to improve the cognition of the users following the works of [8, 21, 31]. They improve the attention, executive functions (decision making, mental flexibility, planning, and problem solving), memory (visual memory, spatial memory, and working memory), and language. The architecture of execution can be seen in Fig. 1.6.

Like the EDLAH2 project, this CA requires direct interaction from the users, being in the paradigm of assisting through interaction.

1.2.8 MyGuardian

The MyGuardian project [18, 32] aims to use technology to facilitate the elderly mobility, keeping their autonomy and dignity. The generated tool helps the users and caregivers by guiding the elderly and reporting situations of confusion or risk to the caretakers. The caretakers have the additional feature of coordinating the daily tasks step-by-step. To this, the interfaces are simple and easy to understand, as seen in Fig. 1.7.

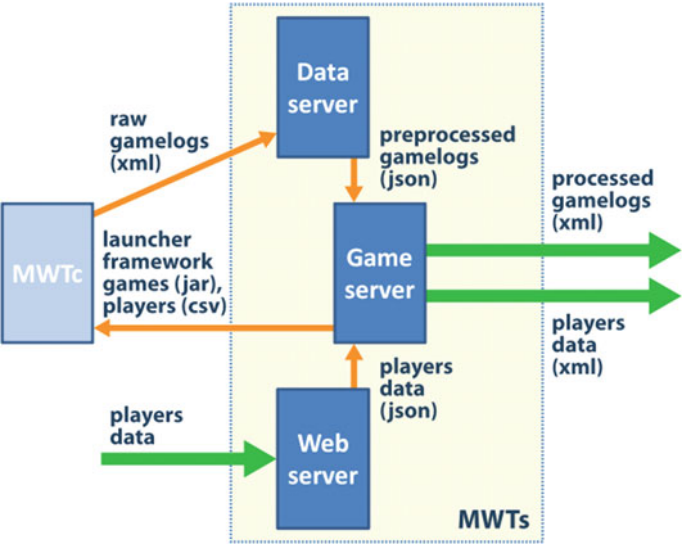


Fig. 1.6 M3W architecture

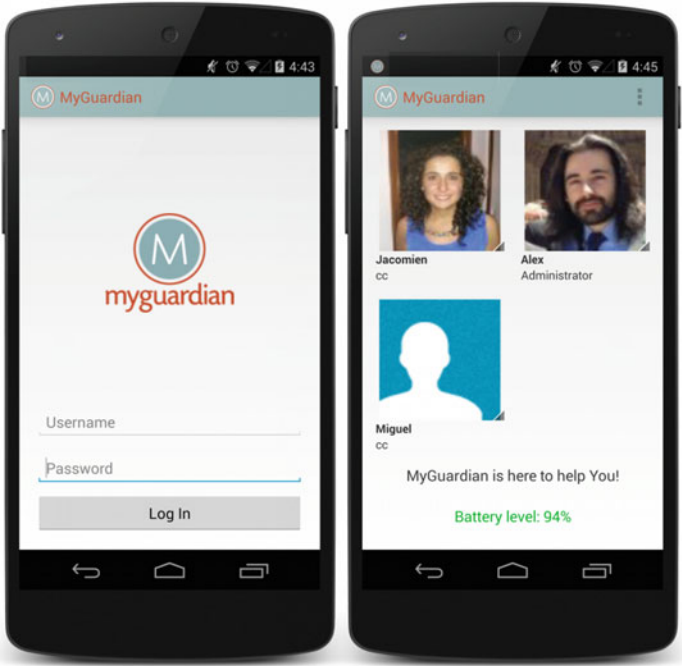


Fig. 1.7 MyGuardian mobile interfaces