

## A New Approach for Ageing at Home: The CAPTAIN System

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### Abstract

Our work exhibits how previous projects on the Active and Healthy Ageing field have advanced to the conception of CAPTAIN, a radically new approach towards increased end-user acceptance. The goal is to create intuitive technology that does not require specific skills for interaction and blends in with real life. CAPTAIN will be co-designed by all types of stakeholders, including older adults, involved in all stages, from the initial design to delivery of the final system.

### Keywords:

Healthy Aging, Home Care Services, Needs Assessment

### Introduction

Ageing is directly related to several issues that may greatly affect the level of independence of an older adult, often requiring institutionalization [1]. However, as a matter of fact, adults typically prefer living at their homes as long as possible retaining their independence. Furthermore, institutionalization has been linked with negative outcomes such as mortality and low quality of life [2].

A wide range of technologies for homecare scenarios have been developed over the last few years including the use of smartphones, tablets, sensors, etc. However, most of them intervene and renovate the user's home or require them to use wearable devices, unable to seamlessly "blend" within the person's daily life and living environment. Moreover, most technologies focus on the patronization of user activity without empowering personalized interventions.

CAPTAIN, which is the acronym of "Personalised coaching for well-being and care of people as they age", proposes an innovative technology that blends in the real-home environments, turning it into an intelligent and ubiquitous coach. The project, which has been funded by the Horizon 2020 work programme proposes to leverage a range of different innovative technologies such as projected augmented reality,

3D sensing technologies, tangible user interaction, and physiological and emotional data analysis to create a virtual coach capable of supporting daily tasks and activities, suggesting a healthy and active lifestyle, and encouraging social participation under the context of a long term coaching strategy.

### CAPTAIN System Description

To deliver an intuitive, transparent, and yet effective interaction paradigm, CAPTAIN transforms the older adults' home into a tangible interface where instructions from the virtual coach are projected onto the real context, whenever and wherever needed. Interaction with the environment occurs by touching real life objects, according to the so-called tangible interfaces, and by voice commands using everyday language.

#### Non-invasive user and environment sensing

User and environmental sensing is done by 3D sensors, RGB cameras, and microphones which are used for:

- User identification and authentication automatically made using face recognition and human body pose recognition (skeleton/silhouette features).
- Creating a profile for each user, not only including data concerning their biological and demographic information, but also their interests and behavioral habits.
- Gait analysis that has been widely used as an indicator of different cognitive impairments [3]. With regards to analysis of movements, CAPTAIN will build upon previous work on indoor analytics [8] where density based clustering was applied to indoor (location) transitions recorded in real older adults' homes for a duration of approximately a year.
- User interaction with so-called "exergames" and cognitive games, engaging the user in physical and

cognitive training tasks, respectively. CAPTAIN will employ a serious games platform, called web-FitForAll [4], incorporating standard physical exercises protocols. The in-game metrics analysis have exhibited a classification accuracy greater than 73% when discriminating between cognitively normal from mild cognitive impaired seniors as well as promising results on creating user profiles using scores created from in-game metrics [5,6].

### Coach behaviour design and Artificial Intelligence (AI) algorithms

The data coming from the cameras, projectors, sensors, etc. analyzed using Artificial Intelligence algorithms will permit information to be obtained about the person's behavior and preferences, as well as the environment. Then, the CAPTAIN coach will use algorithms from the fields of Artificial Intelligence and data mining to integrate the higher-level information about user and environment sensing, combined with behavior change models and domain specific knowledge, to produce personalized motivational guidance embodied through a virtual coach persona specifically designed to support physical and cognitive training, improve nutrition, lifestyle habits and social participation, and reduce risk.

### Human Computer Interaction (HCI) system

The CAPTAIN's HCI will be based on a new prototype device that will create a living environment capable of turning any surface into a projected (augmented) information source. To do so, a spatial augmented reality pipeline will be developed based on two rendering passes, where the first renders the 3D content from the perspective of the senior while, during the second, the generated image is warped into an image to be projected that looks correct from the perspective of the user's eyes and for the environment's geometry.

### Design Approach

While the CAPTAIN's consortium consists of a multidisciplinary team, the main actors of CAPTAIN will be a large group of stakeholders who will be involved throughout the project, providing ideas and insights to which the entire team will be constantly responding and adapting. One of the greatest challenges of introducing new forms of human computer interaction to older adults is to achieve high usability, usefulness, and effectiveness levels, making older adults adopt the solution and not adapt to it.

### Agile methodology

CAPTAIN has been entirely conceived around the idea of co-creation, participatory, and user-centered design which have been proposed to mitigate user acceptance failure frequently observed in older populations. To do so, a hybrid approach leveraging on concepts from Design Thinking, Lean, Startup [7], and SCRUM agile framework [8] approaches are followed by the project. Design Thinking allows the consortium to identify unmet needs and create value from these insights while the Lean approach enables delivering a partially functional prototype frequently enough to the stakeholders in order to collect feedback, validate assumptions, and inform readjustment. The use of SCRUM helps organize work across technical development to collaborate towards delivering high value. This hybrid approach facilitates CAPTAIN to solve effectively, and with high flexibility, the complex project's developments required to achieve its goals.

### CAPTAIN Stakeholders community

The CAPTAIN Stakeholder community becomes the basic source of requirements throughout the project's lifecycle. The CAPTAIN consortium aims for the creation and maintenance of a community with strong support bonds based on two clusters of stakeholders: the first one will include those who will actively use CAPTAIN (older adults and their caregivers), and the second one will include those who can give suggestions or influence (service providers, nursing home management, and patient associations).

### Discussion

CAPTAIN's continuous and unobtrusive sensing of physical, cognitive, and social functioning has the significant potential to support lifelong health management. CAPTAIN uses an innovative projective environment to provide a useful and effective contextualized (i.e. direct projection onto the real world) virtual coach to older adults living at home.

The advantages brought by CAPTAIN will be evaluated during an impact assessment phase which will be tailored to measure the effectiveness in terms of quality of life, societal, economic, and psychological terms. The information and indicators that will be extracted during the assessment phase will be essential to fine-tune the final value proposition in light of later commercial exploitation of the project's results.

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