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Co-Conception Process of an Innovative Assistive Device to Track and Find Misplaced Everyday Objects for Older Adults with Cognitive Impairment: The TROUVE Project

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Abstract

Purpose: Misplacing or losing personal belongings is a concern of everyday life among people of all ages. Older adults with cognitive impairment are significantly more affected by this problem. It is a source of frustration, anxiety, interpersonal conflict and disability in this population. Informal caregivers are greatly impacted by this problem, which compels them to spend a lot of time searching for misplaced items and comforting the person. Assistive technology could thus be of great benefit in this area. However, existing item locator devices do not appear to meet the needs of older adults with cognitive disorders. The TROUVE project aims to conceive and assess an innovative item locator device that effectively addresses their needs, capacities, and goals.

Procedure: The project team conducted a co-design process involving relevant stakeholders (persons with cognitive impairment, informal and formal caregivers, researchers, industry representatives, ethical bodies) using user-tests, focus groups, interviews, and questionnaires. The project plan involved three phases: (1) analysis of end-users' needs, (2) definition of system requirements and iterative prototype development, and (3) prototype assessment.

Findings: The analysis of end users' needs and the evaluation of existing item locator devices provided us with details about the items which are the most frequently lost or misplaced by older adults at home and their coping strategies to manage these situations. The analysis of usability problems observed throughout the assessment of existing devices allowed the definition of the system requirements. Prototype assessment showed that spatialized sound can be used to help these users find missing items, and that an item locator device can be part of a more comprehensive assistive and rehabilitation system such as a robot.

Conclusions: An item locator that relies on sensory information (spatialized sound) rather than on conceptual reasoning ("the item is located to your left 4 meters away") appears to be an interesting solution to address the problem of misplacing personal items in elderly with cognitive impairment. Involving end-users and relevant stakeholders throughout the cycle of design and development of assistive technology is an effective method to explore design opportunities and define creative solutions.

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1. Introduction

World population is growing older, thereby introducing a wide array of challenges. It is estimated that in 2040 there will be three times more people aged over 85 than there are today. Many are expected to need physical and cognitive assistance, due to physical and/or cognitive changes related to ageing.

Cognitive impairment is one of the major health problems elderly people will face in this new millennium. It does not only refer to dementia (e.g., Alzheimer's disease), but also to milder degrees of cognitive deficit such as Mild Cognitive Impairment (MCI). MCI is a clinical condition associated with evident changes in cognitive function and behaviour, which are not severe enough for a diagnosis of dementia [1]. However, in many cases, MCI progresses to dementia.

The recurring loss or misplacing of everyday items is a common phenomenon observed in older adults with cognitive impairment [2]. It has been estimated that over 70% of persons with a clinical diagnosis of Alzheimer's Disease (AD) frequently misplace or loose valuable objects and/or essential everyday items (eyeglasses, wallet, dentures...) [2,3]. Recurrent misplacing induces feelings of anxiety, failure, frustration, and dependence on others in persons with AD. This condition also causes distress and exhaustion among caregivers, since they are often required to spend significant amounts of time searching for lost items and comforting patients [4]. Furthermore, these episodes are a common source of relational conflicts between patients and caregivers, particularly when patients blame caregivers for stealing their possessions. However, misplacement, though often mentioned as an early sign of dementia, remains largely unstudied.

When asked about the tools that could help them improve everyday functioning, older adults with cognitive impairment and caregivers often ask for a system aiming at finding misplaced items [5,6]. A technology-based support system targeting this symptom could have a positive effect on the feeling of self-efficacy, mood disorders (anxiety, depression...) and behavioural disturbances (aggression, apathy...) among persons with cognitive impairment. It may also help reduce caregivers' burden and stress associated with searching for misplaced items and dealing with false accusations.

The interest of electronic devices for tracking lost items has been identified for a long time. Since misplacing objects can be experienced by many people, different technological products designed for tagging and finding small items, such as key finders, have been on the market since the 70s [7]. Some devices currently available are the Loc8tor®, Doro MemoryPlus®, SmartFinder2®, or the "Now You Can Find It!"® Wireless electronic locator. However these devices, commonly using sound tags or basic RFID technology are not efficient enough, especially when they are used indoors. Other weaknesses of these technical aids are the use of large tags difficult to integrate within small objects, poor accuracy and short battery life. Besides, as far as people with cognitive impairment are concerned, the user interfaces of these devices are too complex and inadequate [7] and thus have not been successful so far [8]. The challenge of introducing a new assistive device at home and having to learn how to use it, especially for people with memory problems, is also an important problem [9].

The aim of the TROUVE project, carried out between 2013 and 2016, was to design and develop an assisting device to help older adults with MCI and AD to find misplaced or "lost" personal items at home. The initial idea was to design a technical aid, such as a divining rod used to locate ground water or metals, which could help users track and find their misplaced belongings. For this purpose, we envisioned to specifically develop an active, multi-frequency RFID localization antenna offering unrivalled precision in unequipped environments, and a user-friendly interface for the TROUVE system.

One of the key aspects of the project was to define a useful and non-stigmatizing solution truly adapted to the needs of persons with cognitive impairment, limited technology experience and probable sensory deficits. In order to guarantee the acceptance of the TROUVE system and maximize the system's usefulness and usability, we chose to adopt an "Action Research" methodology [10]. This approach strongly relies on the incremental development of innovative solutions with constant implication of end-users throughout the process and strong valorization of their participation. In this paper we present the different phases of the project, main results obtained with each sub-study conducted within these phases and future directions of work.

2. Methods

2.1. Research programme

The TROUVE project plan included three main phases, each one involving different sub-studies:

- Phase 1 "Assessment of end-user needs": this phase comprised two qualitative studies on the problematic of misplacing personal belongings in persons with cognitive impairment from an ergonomic and an anthropological perspective, and one study focusing on the assessment of existing item locator devices.
- Phase 2 "Definition of system requirements and prototype development": this phase focused on the characterization of the TROUVE system and the development and integration of technical architectures in a functional prototype. Studies were conducted with persons with cognitive impairment, formal and informal caregivers using focus groups and psycho-acoustic measurements.
- Phase 3 "Prototype assessment": this phase involved two studies aimed at testing usability and acceptability of the prototypes developed in the previous phase with end-users and formal caregivers.