



ROBOTS IN ASSISTED LIVING ENVIRONMENTS

UNOBTRUSIVE, EFFICIENT, RELIABLE AND
MODULAR SOLUTIONS FOR INDEPENDENT AGEING

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Abstract

This report refines the functional requirements so that the RADIO system is a medically sound alternative to classical care services models based on close supervision and inpatient monitoring. In addition to passive sensing, this report also determines active actuations that the system should perform. Finally, customization parameters to the target group are also discussed.

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Abbreviations and Acronyms

ADL	Activities of Daily Living
IADL	Instrumental Activities of Daily Living
interRAI	International collaborative to improve the quality of life of vulnerable persons through a seamless comprehensive assessment system. Cf. http://www.interrai.org
interRAI HC	<i>interRAI</i> Home Care Assessment System
interRAI LTCF	<i>interRAI</i> Long-Term Care Facilities Assessment System

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1 INTRODUCTION

1.1 Purpose and Scope

This report refines the functional requirements so that the RADIO system is a medically sound alternative to classical care services models based on close supervision and inpatient monitoring.

Besides passive sensing, this report also determined active actuations that the system should perform, either autonomously or via remote control and telepresence. Furthermore, it is discussed how the different cognitive impairments might influence end-user acceptance, providing input about the kinds of variations or customizations that might be needed in robot design and behaviour for the different cognitive impairments.

1.2 Approach

In the first version of this document (D2.1), the details of the profile of the users target group were defined. In the second version (D2.2), the RADIO medical requirements were established based on the interRAI *Long-Term Care Facilities Assessment System* (interRAI LTCF).

The current report discusses the medical requirements for the private homes use case based on interRAI *Home Care Facilities Assessment System* (interRAI HC). Moreover, active actuations that the system should perform are prescribed and customizations that might be based on RADIO target group are discussed.

1.3 Relation to other Work Packages and Deliverables

This deliverable is a successor of D2.2 and D2.1 (*Early Detection methods and relevant system requirements I and II*, accordingly).

This deliverable along with the *Actual and perceived privacy considerations and ethical requirements II* (D2.4), will set the trade-off between medical requirements and the obtrusiveness off the RADIO System (D2.7).

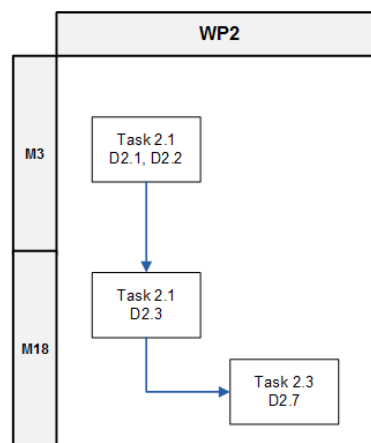


Figure 1: Dependencies between this deliverable and other deliverables.

2 RADIO USERS AND INTERRAI ASSESSMENT ITEMS

2.1 Background: interRAI LTFC

As detailed in D2.1, RADIO users are elderly people (<64 yrs old) that have the ability to walk without human assistance indoors and need supervision in almost two instrumental Activities of Daily Living (iADLs).

In *D2.2 Early Detection methods and relevant system requirements II*, the interRAI LTFC Assessment System was introduced as a suitable tool for assessing our user group. The following Sections and items were considered:

1. Section C. **Cognition:** Cognitive skills for daily decision making, Memory/recall ability, Periodic disordered thinking or awareness, Acute change in mental status from person's usual functioning, Change in decision making as compared to 90 days ago (or since last assessment).
2. Section E. **Mood and behavior:** Indicators of possible depressed, anxious, or sad mood, Self-reported mood, Behavior symptoms
3. Section G. **Functional status:** ADL self-performance, Locomotion / walking, Activity level, Physical function improvement potential, Change in ADL status as compared to 90 days ago, or since last assessment if less than 90 days ago
4. Section H. **Continence:** Bladder continence, Urinary collection device, Bowel continence
5. Sections M. **Activity Pursuit,** activity preferences and involvement, time asleep during day
6. Section J. **Health conditions:** Falls, problem frequency, dyspnea, fatigue, pain symptoms, self-reported health

Each of these items were described in details, along with each coding measures. Moreover, for each item a way to collect the information was defined, based on the following options:

- 1) *Background information*, which includes identification information, intake and initial history as well as other facts.
- 2) *Observation*, which includes observation of physical activity, communication record, etc.
- 3) *Personal Interview*, which includes all data collected by directly interviewing end-users, provided that their cognitive state allows it.
- 4) *Other*, if the information does not fall in any of the above categories.

2.2 interRAI Home Care Assessment System

For the private home scenarios, the interRAI HC Assessment system is adopted. As described in the interRAI HC manual:

The interRAI HC Assessment System has been designed to be a user-friendly, reliable, person centered system that informs and guides comprehensive planning of care and services in community-based settings around the world. It focuses on the person's functioning and quality of life by assessing needs, strengths, and preference. It also assists referrals when appropriate because it facilitates standardized reporting for organizations, regions and nations¹

Another argument in favor of using interRAI assessment instruments is because it has been shown a conceptual overlap in content with the W.H.O.'s International Classification of Functioning, Disability and Health [Ber09]. Using common assessment instruments in the community may help to improve data and reshape policies across social and health policy makers and care providers.

¹ interRAI Home Care (HC) Assessment Form and User's Manual, Version 9.1.2

The interRAI HC sections that are required to be assessed in RADIO are the following:

- Section C. Cognition
- Section E. Mood and Behavior
- Section G. Functional Status
- Section H. Continence
- Section J. Health Conditions

The items used from each section are identical to those items in the relevant Sections of interRAI LTFC and they have been analyzed in D2.2, with the exception of an extra list of items in the Functional Status Section. Instrumental Activities of Daily Living (iADLs) are included in Section G of interRAI HC. These items are analyzed in a way similar to D2.2 in Section 4 of this document. Please refer to D2.2 for the analysis of the rest items.

2.3 Instrumental activities of daily living

As already introduced in D2.2 functional status refers to a person's ability to perform tasks that are required for living and it is generally based on the concept of Daily Living Activities (ADL) through the use of various instruments.

Functional impairment is widely measured using ‘Activities of Daily Living’ (ADL) scales which encompass the assessment of both Basic Activities of Daily Living and Instrumental Activities of Daily Living (IADL). The former includes activities such as dressing, bathing and feeding, while the latter concern more complex activities such as handling finances, taking medication and doing housework. IADL items, requiring more complex neuropsychological organization, are highly dependent on adequate cognitive capacity and are therefore most susceptible to the early effects of cognitive decline [Nje01].

If it is assumed that any decline in cognitive function should have simultaneous effects on ability to perform complex ADLs a concomitant subtle functional deterioration might be evidenced several years before the clinical diagnosis of dementia, yet during the so-called pre-dementia phase of the disease. Previous studies have suggested that complex IADLs, especially four of them (telephone use, use of means of transportation, responsibility for medication intake, and handling finances), are strong predictors of incident dementia [Bar99, Bar02]

Assessing IADL can consequently be useful in detecting and diagnosing early dementia and pre-dementia state like Mild Cognitive Impairment. In fact, Instrumental activities of daily living (IADLs), such as doing one's finances and shopping, are highly dependent on adequate cognitive ability, whereas well-learned activities, such as dressing and bathing, are also dependent on cognition but to a lesser extent.

Functional disability is a core feature of dementia, initially manifesting in impairments in IADLs, [Law69] followed eventually by impairments in basic ADLs, [Kat63]. The recently revised definition of Alzheimer's disease (AD) and Mild Cognitive Impairment due to AD underlines the impact of cognitive impairment on activities of daily living (ADLs) and a decline from previous levels of functioning and performing as core clinical criteria [McK11].

Consequently, about RADIO project, evaluation of IADL is an important feature in the home setting while in nursing home IADLs are often performed with the assistance of professionals.

Presently, there are several approaches to assessing everyday functioning, including self- and informant-report questionnaires, as well as performance-based assessments. Advantages and disadvantages of these approaches include varying cost, accessibility, ease of administration, and availability of normative data. It has been argued that performance-based tests may be the most accurate in determining functional status, as they are the least susceptible to reporter biases. However, the presence of a clinic or lab setting may not reflect the normal home routine and also removes both

environmental cues [Sbo01] and the ability of participants to make use of many typical compensatory strategies (e.g., making a list). In addition, performance-based assessments typically occur at a single evaluation point and can be influenced by the individual’s motivation or engagement during the tasks [Mar09].

RADIO system, monitoring time after time ADL and IADL in nursing home but notably in user’s home, can solve these problems and provide actual functional status.

Table 1 describes the items of IADL self-performance and capacity as used in InterRAI-Home Care.

Table 1. Instrumental activities of daily living

Assessment Item	Description	Measure Scale	Information Kind/Source
<p>1.ADL SELF-PERFORMANCE AND CAPACITY</p> <p>Code for PERFORMANCE in routine activities around the home or in the community during the LAST 3 DAYS</p> <p>Code for CAPACITY based on presumed ability to carry out activity as independently as possible. This will require “speculation” by the assessor.</p>	<p>a. Meal preparation—How meals are prepared (e.g., planning meals, assembling ingredients, cooking, setting out food and utensils)</p> <p>b. Ordinary housework—How ordinary work around the house is performed (e.g., doing dishes, dusting, making bed, tidying up, laundry)</p> <p>c. Managing finances—How bills are paid, checkbook is balanced, household expenses are budgeted, credit card account is monitored</p> <p>d. Managing medications—How medications are managed (e.g., remembering to take medicines, opening bottles, taking correct drug dosages, giving injections, applying ointments)</p> <p>e. Phone use—How telephone calls are made or received (with assistive devices such as large numbers on telephone, amplification as needed)</p> <p>f. Stairs—How full flight of stairs is managed (12–14 stairs)</p> <p>g. Shopping—How shopping is performed for food and household items (e.g., selecting items, paying money)—EXCLUDE TRANSPORTATION</p> <p>h. Transportation—How travels by public transportation (navigating system, paying fare) or driving self (including getting out of house, into and out of vehicles)</p>	<p>0 Independent - No help, setup, or supervision</p> <p>1 Set up help only</p> <p>2 Supervision - Oversight/cuing</p> <p>3 Limited assistance - Help on some occasions</p> <p>4 Extensive assistance—Help throughout task, but performs 50% or more of task on own</p> <p>5 Maximal assistance—Help throughout task, but performs less than 50% of task on own</p> <p>6 Total dependence—Full performance by others during entire period</p> <p>8 Activity did not occur—During entire period</p> <p>[DO NOT USE THIS CODE IN SCORING CAPACITY]</p>	<p>Observation for a,b,d,e,f,</p> <p>Interview for g,h</p>

3 ACTIVE ACTUATIONS

Besides passive sensing, in this section active actuations are also determined. These actuations will be performed by the system either autonomously or via remote control and telepresence. Active actuations will be implemented as notifications sent to care givers (via GUI) or other system actions.

The active actuations can differ in private homes and institutional set-ups. Especially in home settings, the bigger autonomy of the users in comparison with the long-term care facilities or hospice centers, followed by the possible absence of continuous observation by a caregiver, make RADIO system useful in being able to interpret abnormalities or deviations from the daily routine (either in ADL monitoring or in human robot interaction) not only as problems of interaction caused by a recognized cognitive impairment but also as new developments in the disease that might need further attention.

Table 2. Active actuations of RADIO system

ADL	Trigger	Who receives alarm	Information delivery
Locomotion/walking	50% reduction in time execution respect to the mean value recorded the last week	Formal caregivers (both in case of institutional setup and private homes)	Caregiver notification
Personal hygiene	Activity not occur during the last 24h	Formal caregivers (institutional set-up)	Caregiver notification
Meal preparation	Activity not occur during the last 24h	Informal caregivers (private home)	Caregiver notification
Get out of be	Activity not occur during the last 12h	Informal caregivers (private home)	Caregiver notification
Get up from the chair	Activity not occur during the last 12h	Informal caregivers (private home)	Caregiver notification
Take medication	Activity not occur within two hours after the time fixed	Informal caregivers (private home)	Caregiver notification
Alarm required in case of fall	Fall	Formal caregivers (both in case of institutional setup and private homes)	Caregiver GUI notification / RGB camera signal to caregiver.
Forgetting an electronic device switched on	Customized on each user's habits and home.	Informal caregivers (private home)	Caregiver notification
Panic Attack Call	User presses the "Emergency button" on user GUI	Informal caregivers (private home)	The robot reaches the users and transmits RGB camera signal to the caregiver.
Drug compliance	Failed pill intake	Formal caregivers (in case of institutional setup – internal notification)	Caregiver notification
Clear and understandable signals to the patient for every action of the robot. (see D2.4)	Monitoring ADL	End –user	Light/or sound coming from robot indicating that an ADL/mood item has been evaluated.

4 CUSTOMIZATION TO TARGET GROUP

In elderly individuals, cognitive impairment most commonly concerns memory, but it can affect other aspects of cognition such as attention, language, perceptual skills, orientation and problem solving. These problems could affect the user's interaction with the RADIO system.

Moreover, the age-related decline affects the use of computers and other devices because it is associated with decline in physical functions (for example, psycho-motor skills and vision), which makes it more difficult to handle the devices or see the content of the displays.

As monitoring of ADLs and mood is performed by RADIO system without requiring an intervention by the user such service we will not need a special adaptation to the physical and cognitive ability.

The major implication for design is that elderly has to interact with the robot through a touch screen device. The elderly users' abilities are different from person to person and they change over time. Universal design for every older user may be hard to achieve, because there are many different declining abilities and different sets of experience or knowledge. So, designers should provide customized facility for elderly users.

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