**RAMCIP Report Summary**

Project ID: 643433
Funded under: H2020-EU.3.1.4.

**Periodic Reporting for period 2 - RAMCIP (Robotic Assistant for MCI patients at home)**

**Reporting period:** 2016-01-01 to 2016-12-31

**Summary of the context and overall objectives of the project**

Ageing is typically associated with physical and cognitive decline, altering the way an older person moves around the house, manipulates objects and senses the surrounding home environment. These issues pose negative effects on the capacity of older persons to execute daily home activities on their own; effects that are magnified by MCI and its evolution into dementia. The RAMCIP target end users (MCI and early AD patients) can be considered in general capable to establish daily activities on their own, however they are prone to mistakes and abnormalities, mainly due to problems in their memory, judgement and executive functions. The RAMCIP project develops a novel robot that can provide proactive and discreet assistance to elderly people with Mild Cognitive Impairment (MCI) and dementia in early stages in their own home, to support their independent living and quality of life. The RAMCIP robot is aimed to provide assistance to the user in daily activities related to nutrition, medication, usage of electric appliances, socialization, as well as safe domestic locomotion, through user activities monitoring and robot interventions to facilitate the user in corresponding tasks and help counteract for observed abnormalities.

To this end, the RAMCIP robot will comprise three major components: (a) cognitive functions based on advanced user and home environment modelling and monitoring, allowing the robot to decide when and how to assist the user, (b) novel adaptive multimodal human robot communication interfaces, with emphasis on empathic communication and Augmented Reality displays, and (c) advanced, dextrous and safe robotic manipulation capabilities, enabling grasping and manipulation of a variety of home objects, as well as safe physical HRI.

For more information on the RAMCIP project, please visit: [www.ramcip-project.eu](http://www.ramcip-project.eu)

**Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far**

The main results achieved by the project so far can be summarized in the following points:
- The RAMCIP robot end-user requirements have been analysed, resulting into a prioritized list of requirements and use cases for the RAMCIP robot. On this basis, the robot’s technical specifications and architecture have been defined.
- Modelling and monitoring of the home environment: A hierarchical framework for semantic modelling of the end user’s home, along with metric mapping, has been developed. Methods for reconstruction, recognition and state tracking of domestic objects, both large environment objects and small household ones have been developed.
- User activity modelling and monitoring: Methods for human detection, person identification and pose tracking have been developed, as well as for action recognition and monitoring of complex activities, aiming to assess user behaviour and identify abnormalities relevant to the target use cases.
- Robot cognitive functions: The high-level robot behaviour policies in the scope of the project’s use cases have been defined and a POMDP-based approach for the RAMCIP robot cognitive functions was developed. The first version of the cognitive
functions module has been integrated on the RAMCIP robot.

- Human robot communication methods and interfaces: The touch-screen, speech and gestures modalities, the robot’s AR display and the methods for the robot’s affective input (user emotion recognition) and output (robot facial expressions display and affect-driven robot behaviours) have been implemented. The first version of the Communication Decision Maker (CDM) module, orchestrating the UIs was developed, operating along to the robot’s cognition.

- Safe robotic manipulations and grasping: Methods enabling the safe, human-aware navigation for the RAMCIP platform, as well as the safe reaching and grasping of target objects have been researched and developed. The methods have been integrated on the first version of the RAMCIP robot.

- Safe physical human robot interaction: Control schemes for physical human-robot interaction, with respect to ensuring the user safety, were developed. The preliminary design of unintentional contact controllers was also established, targeted at reducing the interaction force via increasing the compliance of the robotic system.

- The first version of the RAMCIP robot’s H/W components, i.e. the mobile platform with elevation mechanism, the robot’s arm and hand, have been developed. These H/W components, along with the first version of the above S/W modules, have been integrated into the first version (V1) of the RAMCIP robot.

- Preliminary trials with the V1 RAMCIP robot and end users, including MCI patients, have been performed in the pilot site of the LUM project partner, in Lublin Poland.

- Several horizontal activities for diffusing project objectives, concepts and achievements to key stakeholders, and the general public have also taken place.

**Progress beyond the state of the art and expected potential impact (including the socio-economic impact and the wider societal implications of the project so far)**

The key innovation points of the project can be summarized as follows:

- Definition of prioritized user requirements and use cases, as well as detailed specifications and architecture for the RAMCIP system; development of the “ArchGen” tool, which facilitates collaborative definition of complex robotic system architectures in ROS.

- Novel methods for modelling and monitoring of the user’s domestic environment and activities, along with cognitive functions that enable on that basis, the provision of proactive and discreet assistance interventions in the scope of the RAMCIP target use cases.

- An advanced adaptive multi-modal human robot communication approach, fusing speech, touch-screen, gestures, an AR display and empathic communication channels.

- Advanced algorithms and methods for safe, human-aware robot navigation and manipulator reaching motion with human-like characteristics, novel grasping methods exploiting environmental contacts, as well as a control scheme for hinged object manipulation following grasping; a novel approach for slippage detection during object transfer; advanced control schemes are investigated for object- hand-over and to ensure safety under both intentional and unintentional contacts.

- The V1 RAMCIP robot has been built; it includes a mobile platform with elevation mechanism and head including facial expressions display and an AR display, manipulator arm and novel hand.

By the end of the project, the RAMCIP robot will be capable of assisting the MCI user in a series of daily activities. By assisting into the independent proper establishment of nutritional and medication activities, as well as by facilitating the user in avoiding risky situations such as falls, or also, through early detection and intervention in case of emergencies related to the user’s health state or the state of the environment, two significant impact dimensions on the primary RAMCIP user are foreseen. The first relates to the suppression of the possibility for risky situations to emerge, which can lead into hospitalization. The second concerns the increased capability of the user to perform typical daily activities, without the need for constant supervision of a caregiver, leading to increased capacity for engagement in daily activities, as well as to an increased feeling of independence.

The RAMCIP foreseen impacts are anticipated to diffuse also to the primary user’s human caregiver, who is typically a user’s relative. By fulfilling its aims, the RAMCIP robot will be capable to undertake caregiving tasks for some periods of time, relieving accordingly the caregiver’s burden, who will be able to spend more time for her/himself.