Periodic Reporting for period 2 - RADIO (Robots in assisted living environments: Unobtrusive, efficient, reliable and modular solutions for independent ageing)

Reporting period: 2016-04-01 to 2017-03-31

Summary of the context and overall objectives of the project

Demographic and epidemiologic transitions have brought a new health care paradigm with the presence of both growing elderly population and chronic diseases. People live longer but in some cases these years are spent with chronic illnesses. This has a great impact to both the quality of life of older people and to the public expenditure for Long Term Care. At the same time, low staffing ratios bring an economic and quality struggle to Institutional Care.

RADIO pursues a novel approach to user acceptance and unobtrusiveness, developing and integrating robotics and home automation technologies that accommodate users’ daily living needs, while assuming interaction with the users as an opportunity for clinical monitoring. In this manner, clinical monitoring sensors do not need to be masked but become an obvious, yet discrete and accepted, part of the user’s daily life.

In pursuing this, the project’s initial technical objective is to develop methods for recognizing Activities of Daily Living (ADL) and mood which indicate early symptoms of cognitive impairment, frailty, and social exclusion. A further objective is to integrate these methods into the RADIO Home, a system based on existing reliable, safe, and low-cost robotics and home automation solutions. Finally, the hardware sensing and processing components of the RADIO Home will form a modular system that can be deployed in different configurations and mixes of components without requiring extensive effort or specialized knowledge for reconfiguration. RADIO also envisages to integrate multiple RADIO Home deployments, medical institutions, and informal care givers into an information management and sharing Ecosystem that is by design scalable and secure and privacy-preserving.

In developing and evaluating these technologies, RADIO emphasises how well the RADIO-provided information can serve its clinical monitoring purpose, how it can be easily reconfigured for different environments and end-users satisfying their individual medical needs and sense of privacy and obtrusiveness, and, finally how usable it is and especially by elderly people.

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 clinical requirements of the system were defined based on the interRAI assessment system, a set of comprehensive and standardized geriatric assessment tools for institutional and home settings. RADIO analysed the machine perception state of the art in order to establish which interRAI items can be automatically recognized reliably enough to be useful and what sensor data is needed for these perception technologies. Besides technical feasibility and privacy concerns with respect to the sensor...
data needed, RADIO carried out a more general discussion on obtrusiveness and how it balances with clinical monitoring requirements.

Clinical and unobtrusiveness requirements guided the design of the RADIO architecture, including the inventory of sensors and perception technologies that RADIO develops and integrates as well as the configurability and modularity of the design. What is stressed in the architecture is the modularity of the design, so that the system can adapt to different environments and to different individual clinical needs and perception of obtrusiveness.

Based on this architectural design, RADIO developed ADL and mood recognition methods that analyse a variety of raw data including audio-visual data, range scans, and text from social media interactions. RADIO also developed and integrated methods for localizing people and objects in the environment based on Bluetooth Low Energy (BLE) beacons, people identification, and home automation device usage. This inventory of elementary methods will be fused into high-level recognition systems.

The methods are physically instantiated on the robot’s on-board computer, on FPGA implementations, or on off-board Raspberry Pi devices. Together with the home automation sensors, this system of processing units creates a heterogeneous wireless networking environment including ZWave and BLE sensors and WiFi sensors and processors. RADIO investigated both the bridging and the communication robustness of this heterogeneous wireless network. The first RADIO Robot prototype and the first integrated RADIO Home prototype were finalized and given for piloting. Finally, RADIO worked towards integrating RADIO Homes and medical institutions into the RADIO Ecosystem, producing network security guidelines and the RASSP protocol for the privacy-preserving mining of the data collected in each Home’s database.

To drive and guide development work, RADIO carried out two formative pilot studies to test both usability and medical efficacy of early prototypes. Overall, the primary users and caregivers showed a positive attitude towards the RADIO system. The medical evaluation results showed that event segmentation is an issue that should be targeted before the next round of pilot studies.

**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)**

RADIO investigated how to bridge the gap between medical requirements and obtrusiveness considering individual preferences. A framework was established that organises the choices that need to be made and assigns obtrusiveness indices to what is technically possible. This will enable making informed decisions about what technical solutions are needed for each given end-user, and also provides insights about which technical advancements will have the most impact. Towards enhancing the competitiveness of EU industry through business and expansion in new markets, RADIO develops a solution that is both scalable and transferable. Architectural and methodological work ensures that multiple RADIO Homes and caregivers can be interconnected in a scalable and secure ecosystem, including RADIO Homes integrating different key enabling technologies and addressing different societal needs and health problems.

In order to technically validate RADIO technologies, technical partners developed two realistic living environments for applying and evaluating RADIO technology: the Roboskel Lab (Athens) and the AAL House (Nafpaktos). The RADIO technology has drawn significant interest from companies specialized in home automation and ambient assisted living technologies, which have contributed as sponsors. Among the sponsoring companies are IKEA, Siemens, ABB, Dialog, CISCO, Embedded Systems and FUJITSU. The latter is considered especially important for RADIO since on one hand it exposes RADIO technology to key technology players and advocates future collaborations, while on the other hand it allows RADIO ecosystem to operate in collaboration with complementary technologies and products offered by the specific companies, which have significant portion of the worldwide market.
Finally, RADIO partners disseminated project outcomes not only at scientific venues, but also at various events targeted to all stakeholders (caregivers, medical doctors, health policy makers) and the general public.

**Related information**

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