IoT, Cloud and Robotics for Ambient Assisted Living

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Abstract. Robots and autonomous systems have the potential to revolutionise the future provision of health and social care. In this talk I will provide an overview of relevant research activities with the focus on some of the ongoing projects at the UK National Robotarium, Edinburgh Centre for Robotics. The overarching goal of our research is the development of user-friendly smart robotic environments combining Internet of Things (IoT) and Robotic technology working together to assist humans, triage issues and facilitate assessment, communication and connectivity as part of personalised and connected health and social care practices. The talk will also illustrate how we use IoT, Cloud and Robotic technology, to support collaboration and foster innovation in the sector.

Keywords. Ambient Assisted Living, Robotics, Smart Robotic Environments, Internet of Robotic Things, Cloud Robotics, Co-Production.

1. Introduction

Ambient Assisted Living (AAL) systems are smart environments designed to sustain healthy ageing. Existing examples rely on wearables and/or sensors embedded throughout the environment to track movement, detect changes in the individual's health status (through historical data analysis), alert carers of falls, and trigger interventions when needed. In this talk I will discuss how robotic, autonomous and interactive systems (RAIS) are increasingly proposed as part of AAL systems. Robots can provide active monitoring as well as social and cognitive support and take immediate action in case of medical emergencies [1]. I will discuss how such an approach is inspired by the robotic ecology concept [3] and past projects in the area [4], taking the term 'robotic device' in a broad sense, including mobile robots, static sensors or actuators, and automated home appliances, working together to provide useful services. I will also discuss its alignment with the more general Internet of Robotic Things (IoRT) paradigm [4][5], i.e. the integration of IoT and Robotic technology for the design of these systems.

2. Example projects

In the first part of my talk I will provide an overview of ongoing initiatives involving the Cognitive Assistive Robotic Environment (CARE) group at the UK National Robotarium.

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For us, the term 'Cognitive Assistive Robotic Environments' embodies a vision: a future where humans are supported by smart environments that can not only sense and react to user behaviour but can proactively engage and cooperate with them using RAIS technology. Drawing on expertise from within the Edinburgh Centre for Robotics and collaborating with psychologists and other social scientists allow us to consider a wider range of research angles. Current research projects include:

- Development of device-free activity monitoring systems utilising Ultra High Frequency (UHF) Radio Frequency Identification (RFID) technology [6].
- Natural language processing (NLP) as part of active (human-in-the-loop) learning approaches for human activity recognition (HAR), so that smart environments can more quickly adapt their services to specific users [7].
- Cognitive architectures to simulate the behaviour or a person affected by mild cognitive impairment / dementia, which are being used to develop cognitive assessment and cognitive assistance systems.
- Novel design methods for non-zoomorphic social robot companions exploiting 3D knitting material and soft robotics [8].

3. Co-Production

In the second part of my talk, I will describe the building blocks and the activities of the Open Ambient Assisted Living laboratory (OpenAAL) project [9]. The vision of the project has been to adopt an “Internet of laboratory things” model [10] to create an open and remote access living lab for AAL, targeting the fast co-creation of socially acceptable, scalable and affordable solutions to support the care of vulnerable people.

OpenAAL aims to provide a collaborative space that researchers, technology and industry users can use to co-create AAL concepts: On-site teams can work together with remote ones, to install sensing and robotic technology for ambient assisted living applications, deploy and integrate (over the Cloud) their software components, such as machine learning software for home activity monitoring and software for socially assistive robots, and test and demonstrate the resulting systems to potential end-users. One key requirement has been to promote the active involvement of end-users in the co-production process by supporting rapid development and iterative R&D cycles, starting from mocked-up demonstrations, where robots are remotely controlled using tele-presence interfaces, in a wizard-of-oz (Woz) style.

I will give an overview of the technological solutions we have employed, and describe the experience and the results of a pilot event, which we run in May 2021, i.e. a one week-long course on assistive technology and robotics (Robotic + Care Mashup) – to healthcare professionals and academic attendees. The event featured online demonstrations of assistive and tele-presence robotics. We also offered the use of cloud-based robot control software to the teams interested in controlling our robots, remotely, over the Internet. I will discuss how the project has enriched our innovation but also our learning and teaching capacity, and how it has sets an example for how innovators, academia and the care sector can be pulled together to co-produce AAL concepts.

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