Impact Objectives

- Develop a system which provides the elderly population with increased autonomy and independence, and assists in the daily aspects of their lives
- Provide highly personalised communications and content for the web, for example movies and music – for individual elderly people
- Ultimately improve the quality of life for the world's expanding ageing population

Person-centred care with ICT

Professor Masahide Nakamura *discusses his work to provide person-centred care for elderly people at home, using affordable assistive technologies and systems*

Could you begin by explaining your background and how you became interested in system informatics?

When I was seven years old, my father brought a PC home. I was very excited to play with it. As this was 40 years ago, nothing was as convenient as today. Using computer magazines, I started programming and learned how software worked on the PC. I've been interested in computer science since this time. I obtained my PhD from Osaka University in Japan and after graduating I worked for Ottawa University in Canada, doing a postdoc for a year, then returned to Osaka University. I later moved to the Nara Institute of Science and Technology (NAIST). Ten years ago, I joined Japan's Kobe University, which is where I am currently based. Moving around various institutes, I was attracted by many aspects of software. System informatics studies, the integration of various systems using information technology, allows me to take full advantage of my background in software.

A PCC (person-centred care) experiment at a day care centre

How did your current project come about?

In October 2013, Seiki Tokunaga entered my lab as my first PhD student. At the time, we were studying home network systems (known today as smart homes). As Seiki began his PhD course, I wanted to embark on a more useful and challenging research theme. Initially, my idea was to make full use of the home network system for the elderly, since a rapidly ageing society is a global social problem. However, there were many gaps between the homes of elderly people and the research lab. Our research used a technology-driven approach, but as we met actual elderly people, caregivers, therapists and doctors, we found this approach to be meaningless for practical situations. This was when we found the notion of person-centred care (PCC), introduced by Tom Kitwood.

As we studied PCC, we found that the principle itself is quite important, but providing PCC continuously requires a huge human effort of professional caregivers and it is almost impossible to do PCC at individual houses. So, we established an ambitious goal to make PCC feasible at home by making ICT and the Internet of Things (IoT) affordable for home users. The project is now at the five-year mark and a lot of great ideas have been implemented as actual systems. Seiki obtained a PhD in 2016, and is currently working for Riken AIP, a top national research institute in Japan.

What are the main benefits the 'Virtual Care Giver: Virtual Agent for Personalized Home Elderly Care' system offers to users?

The main benefit is providing highly personalised communications and content for the web for individual elderly people. The content includes pictures, music and movies. The elderly can enjoy the contents even if they cannot use a PC or smartphone. Looking ahead, we want to add functionalities to evaluate the effects of the care the agent provides.

How adaptive is the system to individual users? Will it evolve automatically, or would there be a need for regular maintenance by a third party?

The system will evolve automatically. Through conversations and communications, activity labels are attached to stream data. This means the system gradually recognises what is going on and what needs to be done. Since the system contains physical devices including sensors, there would be some necessary regular maintenance. Most of the maintenance tasks can be automated, but we will look into this when the system is released for market.

Could you summarise your progress so far?

The project is currently going well. Students are also very interested in developing and evaluating the system. This means everybody recognises the project is meaningful and wants to make it a success. ▶

Improving the quality of life

*At Japan's **Kobe University**, researchers are working to improve the quality of life of the elderly by developing systems that can provide person-centred care at home, giving them greater independence*

The rapidly ageing population is a known phenomenon that is observed across the globe. However, being elderly should not mean a compromised quality of life, and with the development of technology comes the ability to provide the elderly with autonomy and help assist them in their lives. One team of researchers is interested in the super smart society (Society 5.0) – the next-generation society, where heterogeneous systems are interconnected over cyber and physical spaces to provide advanced services for individual citizens – and is hoping to exploit its full potential.

Professor Masahide Nakamura of Kobe University, Japan, is heading up this work.

Autonomous SensorBox

It is a branch of gerontechnology, in which technology is directed by opportunities for the elderly, but focuses specifically on person-centred care (PCC), as Nakamura explains: 'We are studying how the system autonomously considers the individually different situations and backgrounds of elderly people, in order to improve the quality of life at home.' The goal of Nakamura's work is to provide PCC for the elderly at home, making use of assistive technologies and systems that are affordable. 'The issue of our ageing society is spreading across the world. Japan is the most "advanced" country in that context and a lot of elderly people are living alone,' he explains. 'The number of one-person households is dramatically increasing and will represent 37.4 per cent in 2030 (including both young singles and the elderly). So, it is a natural direction to introduce technologies to help take care of ourselves.'

SERVICE-ORIENTATED ARCHITECTURE

Nakamura's work surrounds service-orientated architecture (SOA), an architecture paradigm in software engineering whereby each feature of a system is considered to be a service and the services are exposed to a network.

His group in the Nakamura lab – CS27b – is exploring how SOA can be applied in practice from a software engineering perspective. For example, the researchers are working to develop a smart home system called CS27HNS, which is powered by an SOA and enables household appliances and sensors to be operated via the web. Furthermore, they are working on the idea of integrating multiple smart homes in a city together with city infrastructure in order to solve problems in the city; a so-called smart city. The researchers are also looking into smart healthcare, drawing on ICT as one of the most promising technologies for safe and high-quality living. One of the services the researchers have developed is called 'Virtual Care Giver: Virtual Agent for Personalized Home Elderly Care', which does what it says on the tin. According to Nakamura, the real value comes from the integration of different components: 'The virtual agent technology itself is not very new or surprising. However, integrating it with various components to provide value-added services is important. Traditionally, researchers have concentrated on polishing one thing for better quality. However, I think there are many good

things available. So, it is more important to integrate them to create useful services for people and society.'

The original version of the Virtual Care Giver was developed by Seiki Tokunaga, a former doctoral course student, who designed and built the basic components of the system. The system is in constant development, integrating smarter features and services. Other key members of the team are: Seiji Sakakibara, a former Master's student who implemented the Autonomous SensorBox – an IoT device that captures environment data and uploads the data to private cloud servers in the team's lab; and Kazunari Tamamizu, a former Master's student who developed the AI system that understands the activities of the elderly at home. Nakamura is also working with Kiyoshi Yasuda, a speech therapist at Chiba Rosai Hospital, who provides the team with professional advice and practical ideas and cooperates on the clinical evaluation of the system, and Masae Yokota, a social worker in Yoriai-Dokoro Ren, who assisted the researchers with conducting an experimental evaluation of their system.

PERSONALISED CARE

The Vitual Care Giver uses emerging face recognition and image processing technology to generate a 3D model of a face from a given picture. Services such as text-to-speech, speech-to-text, dialogue and facial expression are made available to the user. It uses a profile of each elderly person to provide personalised care that is customised to the individual. In addition to being used for care of the elderly in their homes, it can also be used for psychological counselling.

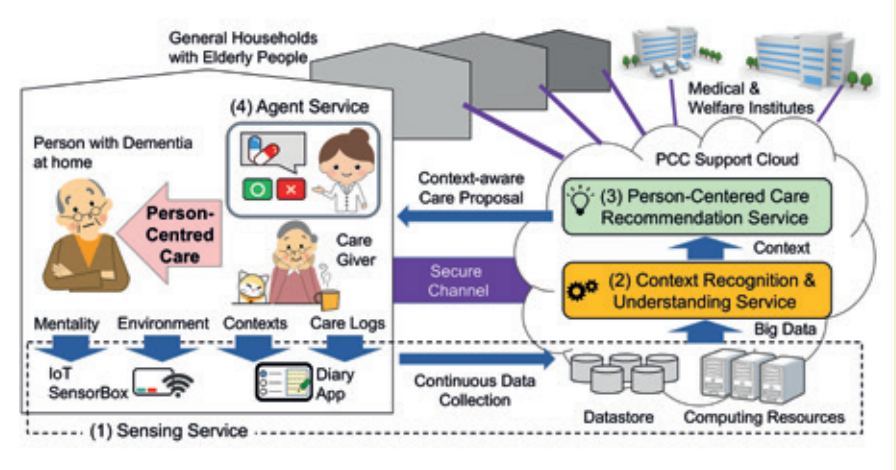
Although other integrated virtual agent interfaces are in existence, these all work based on predefined scripts and scenarios.

What makes Nakamura's system particularly innovative is the fact it strives to adapt to different situations and backgrounds, delivering personalised services. 'The adaptation is autonomous. The system knows the situation from sensor readings, as well as the user's preference/profile obtained through conversations. Of course, the system learns from the data to see what care is appropriate for that elderly person in that situation,' he explains.

A BUDDY FOR EVERYBODY

The key challenge the team faces concerns integrating the different heterogeneous components, as Nakamura explains: 'For the autonomous SensorBox, we implemented software modules to automatically monitor the status of sensors and the network, and to restart the system when any fault occurs,' he explains. 'This kind of IoT system consists of a number of components, so the reliability of the system is determined by the multiplication of the components. The real challenge is not in development, but in operation. Thus, we found it important to decipher how to minimise human effort for operation and maintenance.'

Looking ahead, Nakamura hopes the system his team has developed will prove indispensable to the elderly and will be an integral part of life: 'The ultimate challenge is to realise a society where the virtual agent will truly be a "buddy" to every elderly person. Currently, the virtual agent behaves based on externally observable data, which is quite an engineering-based approach,' he explains. 'To achieve the goal, the agent has to understand the internal status of every elderly person, including emotions and pains. This is quite a challenging issue.' Although challenging, the team appears to be on target to achieve its goal, and with some of the brightest minds working towards a common aim, the researchers seem set to succeed.



Architecture of a Person-Centred Care Support System

Project Insights

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COLLABORATORS

Seiki Tokunaga – RIKEN AIP, Japan • Seiji Sakakibara – Kobe University, Japan • Kazunari Tamamizu – Kobe University, Japan • Kiyoshi Yasuda – Chiba Rosai Hospital, Japan • Masae Yokota – Yoriai Dokoro Ren, Japan • Kenji Hatano – Doshisha University, Japan • Jun Miyazaki – Tokyo Institute of Technology, Japan

CONTACT

Masahide Nakamura
Principal Investigator

T: +81 788036398
E: masa-n@cs.kobe-u.ac.jp
W: https://cs27.org/

PROJECT COORDINATOR BIO

Masahide Nakamura received his BE, ME and PhD degrees in Information and Computer Sciences from Osaka University, Japan, in 1994, 1996, 1999, respectively. From 1999 to 2000, he was a post-doctoral fellow in SITE at the University of Ottawa, Canada. He joined Cybermedia Center at Osaka University from 2000-02. From 2002-07, he worked for the Graduate School of Information Science at Nara Institute of Science and Technology, Japan. He is currently an Associate Professor in the Graduate School of System Informatics at Kobe University, Japan. His research interests include service/cloud computing, smart home, smart city and gerontechnology.

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