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Works in Progress: Healthcare Systems and Other Applications

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Vol. 6, No. 1
January–March 2007

Works in Progress

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Healthcare Systems and Other Applications

EDITOR'S INTRODUCTION

The eight projects in this issue's Works in Progress department address various healthcare topics. The first project aims to aid people with mild dementia. The second project plans to simplify the delivery of healthcare services to the elderly and cognitively disabled, while the third project is developing models for monitoring elders' home behavior. The fourth project is testing RFID-based personal nutrition monitoring approaches. The fifth project is improving the text-to-speech quality of book readers for blind readers, and the sixth is about image-based tools for aiding people with autism. In the seventh project, the authors are developing models for improving smart clothing, specifically the selection and placement of electrocardiogram monitoring electrodes. The final project is a wireless system for assisting independent elder living.

—Anthony D. Joseph

HELPING PEOPLE WITH DEMENTIA NAVIGATE THEIR DAY

Rose-Marie Dröes, *Vrije Universiteit Amsterdam University Medical Center*
Maurice Mulvenna and Chris Nugent, *University of Ulster*

About two percent of Europe's aging population—1.9 million people—suffer from mild dementia. In recent studies, people with dementia have commonly identified several unmet needs, including information (for example, regarding treatment or support), communication, and help for memory problems and psychological distress.

With the European Commission's support, the COGKNOW project is attempting to address these needs, particularly by involving individuals with dementia for the entire project. In practice, we aimed to help people navigate their day by helping them remember important daily activities, maintain social contact, perform daily activities, and feel safer.

Our overall goal is to use contextual information and wireless and mobile device technologies, including location-based services, to create a cognitive prosthetic prototype. People with mild dementia can use this portable, configurable device in their homes or wider community. Existing devices and services have had mixed success when applied to actual living conditions among aging people with mild dementia. We seek to address these issues by involving individuals with dementia closely in the prosthetic's design and implementation.

The first user interactions began in November 2006 in Sweden, Northern Ireland, and the Netherlands.

David Craig (Belfast City Hospital and Queen's University of Belfast), Ferial Moelaert (Telematica Instituut), and Tony Scully (Luleå University of Technology) also contributed to the design of this project. For more information, contact Maurice Mulvenna at md.mulvenna@ulster.ac.uk or see www.cogknow.eu.

EMPOWERING THE ELDERLY AND THE COGNITIVELY DISABLED

Marius Mikalsen and Ståle Walderhaug, *Sintef Information and Communication Technology*

Developing information systems to provide mobile and pervasive healthcare services to elderly and cognitively disabled persons is complex and resource demanding. The task involves many stakeholders and legacy systems, and the design and developer teams face several challenges, including

- choosing an architectural style,
- reusing existing components,
- selecting divergent sensor programming interfaces, and
- complying with national and international healthcare standards.

Consequently, our group at SINTEF (the Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology) must deal with numerous nonstandardized legacy systems and components, making maintenance and upgrades expensive and difficult. Sharing information and services between the systems is both time-consuming and expensive, due to the lack of interoperability.

By applying an agile model-driven development process, the M·Power project will develop a service framework that provides reusable, flexible, and interoperable service specifications and implementations. The resulting framework will

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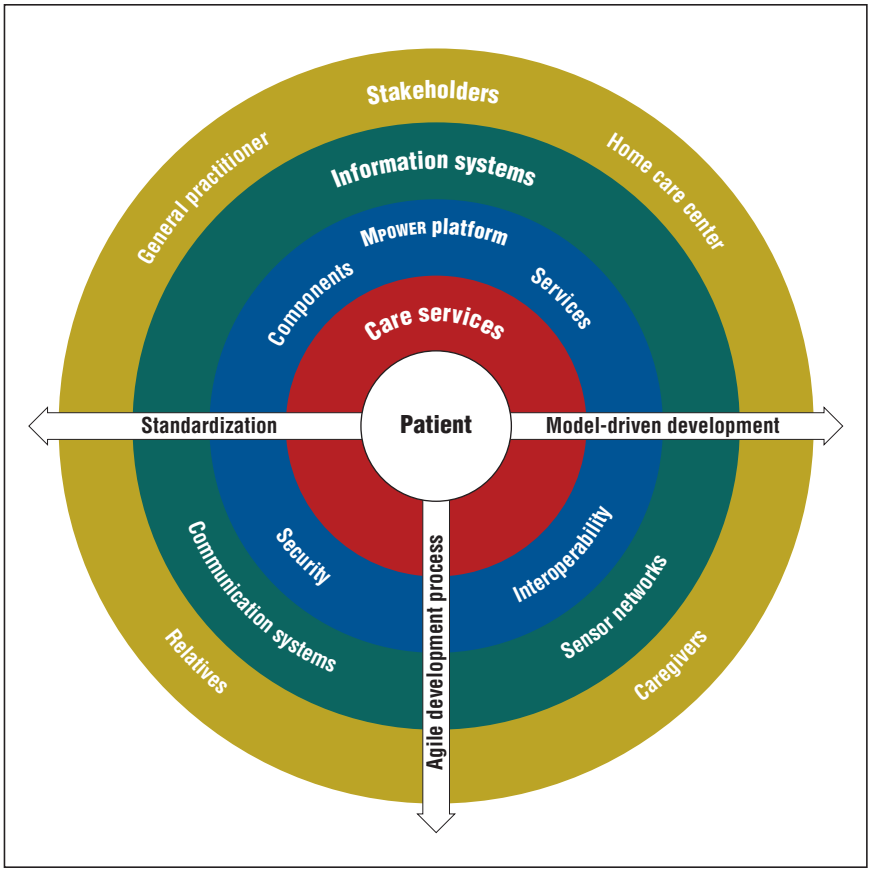

Figure 1. The M·Power framework.

shorten time to market for new, standards-based, and innovative services for elderly and cognitively disabled people. Furthermore, it will enable the development of novel smart-home sensor applications to support collaborative care and management of such persons in their homes, empowering the users toward independent living.

The project will promote standardization by aligning its work with OMG/HL7 (Object Management Group and Health Level Seven) and CEN/TC 251 (European Committee for Standardization of Health Informatics). It will partner with the International Association of Homes and Services for the Aging to promote the M·Power framework (see figure 1) internationally.

We'll rigorously evaluate the platform's usability in controlled experiments in Norway and Poland. The first preliminary results will be available in November 2007.

The M·Power project is funded by the European Union as project number EU-IST 034707. For more information, contact Marius Mikalsen at marius.mikalsen@sintef.no or Ståle Walderhaug at stale.walderhaug@sintef.no or visit www.mpower-project.eu.

CONTEXT AWARENESS IN RESIDENCE FOR ELDERS

Tim van Kasteren and Ben Kröse, *University of Amsterdam Intelligent Systems Lab*

The growing population of elders in our society calls for a new approach in caregiving. In the Context Awareness in Residence for Elders (CARE) project, we're exploring techniques that let elders retain their independence by living at home longer. By using a collection of simple sensors, such as contact switches and pressure mats, we monitor inhabitants' behavior unobtrusively. Not only will this technology reassure the families, but the elders will also feel safer when performing tasks and living their lives.

Our group has successfully developed methods for analyzing temporal patterns in sensor readings. We've applied these methods to visual-surveillance and music-analysis applications and are now focusing on automatic health monitoring. By first learning a model from observing the elders' daily activities, our system can monitor the subjects' health and provide evidence-based care. So far, we've been using data sets to evaluate our experiments. However, we're talking to various healthcare parties in the Netherlands to perform real-life experiments.

For more information, contact Tim van Kasteren at tlmkaste@science.uva.nl or see www.science.uva.nl/~tlmkaste.

RFID-BASED NUTRITIONAL ASSISTANCE

Stefano Puglia, Fabio Scanu, and Marco Oreste Migliori, *WLAB Srl*

The worldwide healthcare sector is increasingly concerned about public health issues related to people's food choices and nutritional patterns. The food industry, public health educators, and policy makers need new ways to influence and improve people's decision making and behavior concerning food choice to help them meet their nutritional needs.

At the WLAB, we've used low cost, high-frequency passive RFID technology (adopting the MIFARE standard) to develop a personal software assistant for eating outside of the home. The tool automatically customizes food menus according to personal profiles including allergies, intolerances, dietary patterns, caloric intake, and budget information.

As a proof-of-concept, we've created prototypes for two approaches:

- A standard enterprise information system integrating RFID lets users

scan their own RFID-enabled nutritional card on an RFID reader integrated into the food establishments' information system to receive a customized menu (see figure 2).
- A typical form of RFID-based "augmented paper" uses physical menus tagged with RFID labels. Users can read the labels, which contain information about food composition, with RFID-enabled mobile devices. An ad hoc personal application then customizes food choices on the basis of configurable personal profiles (see figure 3).

Ongoing studies carried out with the University of Rome "La Sapienza" are assessing performance and usability issues for both approaches. The prototypes have been implemented in Java to be open and cross-platform on both the server (Linux and Microsoft) and the client (SymbianOS and Windows Mobile PocketPC).

For more information, contact Stefano Puglia at stefano.puglia@w-lab.it or visit www.w-lab.it.

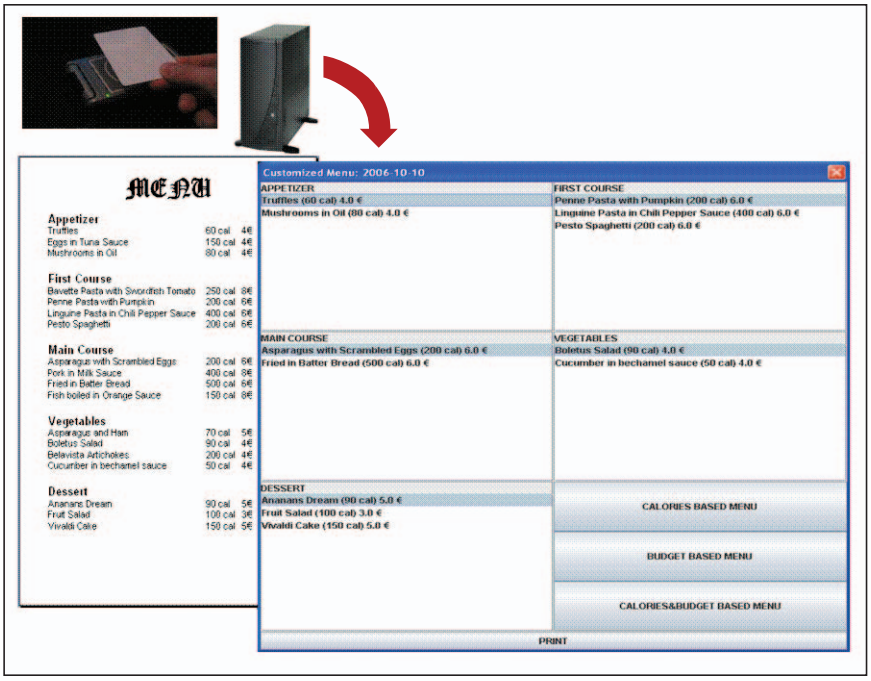

Figure 2. An RFID nutritional card with a vegetarian profile.

Figure 3. Menu customization on mobile devices.

A COMPUTER-BASED LIBRARY FOR THE BLIND

Erdem Uçar, Cenk Atliğ, and Yılmaz Kılıçaslan, *Trakya University*

Our project is developing a software system that aims to give blind people access to conventional paper books using their tactile and auditory senses. First, we'll transfer paper books to digital media and then make their contents accessible to users via either a Braille system or a text-to-speech module.

So far, we've set up a Braille system and developed a text-to-speech module for Turkish, although we haven't yet considered prosodic issues. We're now making the text-to-speech module's output less mechanical by incorporating principles of intonation, drawing on various theories of linguistics and natural-language processing. However, implementing intonational features will more likely give us an effective, efficient system than entirely natural-sounding results.

We're collaborating and cooperating with two centers for disabled people, and a state library is sharing with us their experiences with blind users.

The University of Trakya Scientific Research Project Office supported this work with grant number TUBAP-761. Özlem Uçar and Erdinç Uzun (Cognitive Science Society of Trakya) also contributed to this project. For more information, contact Cenk Atliğ at

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cenk.atlig@computer.org or see http://tbbt.trakya.edu.tr.

AN NLP-BASED TOOL FOR ASSISTING PEOPLE WITH AUTISM

Yılmaz Kılıçaslan and Özlem Uçar, *Trakya University*

Assistive technology offers great opportunities for disabled people to communicate and socialize. People with autism suffer the disability of thinking and communicating in images, without the mediation of language. Thus, we propose that people with autism need to be supported with easily available, user-friendly tools that give them visual images representing thoughts and expressions. Such a tool should be a natural-language-processing system equipped with a visual representation module.

We've developed an NLP-based software system that represents the semantic contents of linguistic expressions in still photographs and animations from a cognitive science perspective. We intend for people with autism to use the system as a tool for education, communication, and socialization without being confined to special-education centers. We're testing the tool with children with autism at two different centers for disabled people. We're conducting the tests sequentially, starting with the least complex pairings (for example, word-object pairs) and proceeding to more complex ones (for example, sentence-situation pairs and discourse-course of affairs pairs). We hope that our statistical and theoretical evaluation of the tests will show us how useful and effective the tool is in real life.

The University of Trakya Scientific Research Project Office supported this work with grant number TUBAP-760. Edip Serdar Güner and Erdem Uçar (Cognitive Science Society of Trakya) also contributed to this project. For more information, contact Cenk Atliğ at cenk.atlig@computer.org or see http://tbbt.trakya.edu.tr.

MAKING SMART CLOTHING SMARTER

Dewar Finlay, Chris Nugent, and Mark Donnelly, *University of Ulster*

Technological solutions are rapidly becoming more prevalent for supporting independent healthcare management. An opportunity exists in the development of truly intelligent wearable systems. Specifically, smart textiles now make it possible to create clothing that can perform electrocardiogram (ECG) monitoring (see www.sensatex.com). Nevertheless, several practical constraints make it difficult to place electrodes within such systems. These constraints relate to both the manufacturing of the garments and clinical issues surrounding the most appropriate positions for recording cardiac information.

We've developed a suite of computational models that support the selection and positioning of ECG electrodes to capture maximum body surface ECG information. Driving our work has been the concept of identifying—before deploying any selection algorithms—specific regions where the electrodes can be selected on the basis of the aforementioned practical constraints. These choices are driven by domain knowledge, for example sets of posterior or anterior recording regions.

We're going to use results from our modeling experiments to develop a series of prototype wearable systems that will facilitate in situ evaluation. Specifically, we'll use the results to develop a recording apparatus that will support specially designed smart vests. Once developed, we plan to evaluate the system with a limited number of users to validate our theoretical propositions. We anticipate a positive evaluation, which will subsequently provide new electrode placement paradigms that we can later deploy in wearable systems to improve cardiac assessment.

Paul McCullagh and Norman Black (Univ. of Ulster) and Bob Kalik (Sensatex) also contributed to this project. For more information, contact Dewar Finlay at d.finlay@ulster.ac.uk or visit www.ulster.ac.uk.

PAS: A WIRELESS-ENABLED PERSONAL ASSISTANCE SYSTEM FOR INDEPENDENT LIVING

Jennifer Hou, *University of Illinois at Urbana-Champaign Index Group*

Aging baby boomers are creating social and economic challenges. In the US alone, the number of people over age 65 is expected to hit 70 million by 2030, doubling from 35 million in 2000. As the population ages, demands on healthcare resources will increase. Fortunately, advances in sensing, event monitoring, and wireless communications technologies make it possible to unobtrusively supervise an elderly person's basic needs, thereby replicating services from on-site providers and family members.

The Illinois Network Design and Experimentation Group has been developing and deploying a wireless-based software infrastructure, the Personal Assistance System. PAS has sensing, localization, monitoring, wireless communication, and event- and data-management capabilities. It exploits inexpensive, off-the-shelf technologies to help elderly people maintain their independence by providing reminders of daily activities, nonintrusive monitoring of physiological functions and mobility profiles, and real-time communication with remote care providers and clinicians. Specifically, we've

- given PAS a quality-of-service-compliant network of small, low-power devices, which integrates RFID readers and bluetooth-enabled medical devices;
- equipped PAS with ultrasonic and RFID technologies that let it track humans and objects in real time;
- made PAS ubiquitous by using cell phones as both the wireless modem

and the local intelligence for data aggregation and acquisition; and
- incorporated into PAS a fall-detection and response system to track residents' orientation.

We're also investigating security, privacy, trust, reliability, and HCI issues in the context of PAS. Finally, we're working with Washington University in St. Louis to evaluate PAS prototypes at an assisted living center.

The National Science Foundation supported this work in part. For more information, contact Jennifer Hou at jhou@cs.uiuc.edu or visit http://index.cs.uiuc.edu.